

Project title: Comparison of Different Planting material for Fruit Wall Orchard Systems for Apple

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Project leader: Tim Biddlecombe
Fruit Advisory Services Team LLP
Brogdale Farm
Brogdale Road
Faversham
Kent
ME13 8XZ

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Location of project: Brogdale Farm, Brogdale Road, Faversham, Kent
ME13 8XZ

Industry representative: Mark Holden

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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Tim Biddlecombe
Managing Partner
Fruit Advisory Services Team LLP

Signature Date

Report authorised by:

Dr William E Parker
Director of Horticulture
The Agriculture and Horticulture Development Board

Signature Date

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GROWER SUMMARY

Headline

This research project will compare the establishment of different tree types for Fruit Wall systems using a standard variety, rootstock and spacing.

Background and expected deliverables

As growers consider adopting and planting new orchards for the Fruit Wall growing system for apples (*Malus domestica*), they face a challenge in deciding which tree type to select. Conventionally produced trees have a form and structure ideally suited to wider spacings, where a branch framework is necessary, although these can be adapted to be managed in a Fruit Wall planting. However, other tree types may be more suitable to Fruit Walls, either because they are cheaper and can be planted more intensively at the same cost per hectare, or because they have been specifically grown in the nursery to form a narrow, tall tree, potentially giving higher, early yields.

The Fruit Wall system may offer significant benefits to growers as it lends itself to increased mechanisation which helps to reduce labour costs incurred by pruning and tree management. However, these benefits will only result in increased returns if yield and fruit quality are not compromised.

Following the successful development and commercial uptake of the Concept Orchard by many UK growers (HDC Project TF 151), further evolution and development of more intensive planting systems is being considered. In TF 151 the development of a new orchard system in France (Le Mur Fruitier) was referred to. Further developments of this system have been carried out privately at the PC Fruit Research Station in Sint Truiden, Belgium. Generally this work has been done in existing orchards that have been adapted to the new pruning regime and on varieties not grown in the UK. Results have shown that the principles developed in the work by CTIFL in France can apply in growing areas further north. However, they need to be adapted to local growing conditions and varieties, as the timing of pruning is critical and is specific both to individual varieties and the length of the growing season in different geographical areas.

Little research has been done to identify the optimum way of establishing orchards of this type or which type of tree gives the best results. Several specialist nurseries are now developing tree types designed and grown especially for 'Fruit Wall' orchards. These include 'grow through trees' from several nurseries, and Bibaum® trees from Mazzoni nurseries. Other nurseries recommend that using a maiden tree or an 8 month tree at a close planting distance can give better results.

This research project will compare the establishment of different tree types using a standard variety, rootstock and spacing. It will ultimately provide growers with comparable data to allow them to make informed decisions.

Summary of the project and main conclusions

Five distinctly different planting materials ('tree types') will be compared in a Fruit Wall orchard managed to Integrated Crop Management standards. The planting and establishment of the trees took place in 2013. Records and assessments will commence in 2014.

Financial benefits

The cost of establishing an intensive orchard is currently between £22k - £28k per hectare. The payback period should be as short as possible and one of the major influences on this is the type of tree that is planted and its cropping potential in the early years. The differences in cost of the various tree types available is quite small (typically around £0.50 per tree or £1,500 per ha), but a reduction in yield of 5% in each of the first four cropping years can reduce net returns by around £3,000 per ha. Some tree types have the potential to fill their space (vertically and horizontally) very quickly, leading to increases in early yields. Others require more pruning and thinning to achieve successful establishment.

Although new intensive orchard systems are simpler and easier to prune than lower density traditional orchards, it can still take between 25 and 40 man hours to prune a one hectare orchard. Rates of mechanical pruning vary between 1.5 and 2.5 hours per ha, depending on planting distances. Some hand pruning will be needed even where mechanical pruning is used but net savings of around £3,000 per ha over a 15 year orchard life are envisaged (net of machinery cost).

Anecdotal evidence from experimental plots in Northern Europe suggests that annual yields from Fruit Wall plantings can be around 20 tonnes per ha greater than orchards of a similar density managed conventionally. The value to the grower of this increase would be approximately £21,000 net of all post harvest costs over fifteen years.

Action points for growers

The 2013 season was the planting and establishment phase of the trial. The action points for growers have yet to be determined.

SCIENCE SECTION

Introduction

Growers in many countries are actively looking for ways to reduce labour inputs and increase mechanisation in a range of fruit crops. The Fruit Wall concept originated in France in 1986 when CTIFL began a project which aimed to reduce growing costs in top fruit production. Around the same time a harvesting robot, known as the Magali, was developed and CTIFL adapted an orchard to create a narrow tall hedgerow (the 'Fruit Wall') to accommodate the robot and maximise the use of automation at harvest. As a result, the work by CTIFL demonstrated the potential of the Fruit Wall growing system in reducing the costs associated with hand pruning and increasing Class I yields. However, differences in cropping were shown between the south and north of France, with the trial plots in the north performing less well than those in the south.

The Fruit Wall system is now being considered as an option for commercial practice in the UK, as mechanisation of pruning and other operations (for example thinning) is possible and requires modified tree architecture to be successful. Results from the original work by CTIFL in France can be applied to growing areas further north, but only by adapting the methods, particularly the time of pruning, to the local growing conditions.

Three key factors influence total productivity from a Fruit Wall orchard:

- Planting density
- Tree architecture
- The timing of pruning

These factors all have an effect on extension growth, flower initiation and yield by influencing light interception and distribution by and through the canopy and the total amount of fruiting wood in the orchard. The management of these factors determines whether the Fruit Wall is able to provide increased and sustainable yields throughout the life of the orchard.

Hampson *et al.* (2002) demonstrated that planting density can have a greater influence on productivity than the training system (tree height and shape). Trees planted at lower density were more productive per tree than at a higher planting density due to reduced competition for resources. However, higher planting densities tend to be more productive per hectare. Palmer *et al.* (1992) suggest that Leaf Area Index (LAI) increases with increased planting density with greater light interception as a result. Higher planting density systems tend to increase yields per unit area through more efficient use of ground area until

a natural limit is reached (Weber, 2001). For the Fruit Wall system to achieve greater productivity it should make improved use of the unit ground area than traditional orchard system designs.

Hampson *et al.* (2004) demonstrate in their study that the percentage of fruit with acceptable colour was reduced with increased planting densities. Red colouration is an indicator of fruit quality and, therefore, as planting density increases the percentage of Class I fruit may become compromised. The tree architecture of the Fruit Wall system has the potential to overcome issues such as reduced red colouration, as the trees tend to be narrower than in traditional orchards and result in less shading of the fruit.

Little work has been done on ways of establishing orchards of this type and which type of tree gives the best results. Several specialist nurseries are, however, developing tree types designed and grown especially for Fruit Wall orchards. These include 'grow through trees' from several nurseries, and Bibaum™ trees from Mazzoni nurseries. Other nurseries recommend that using a maiden tree or an 8 month tree at a close planting distance can give better results.

The trial will provide a comparison of different tree types using a standard variety and rootstock and spacing and provide growers with comparable data to allow them to make informed decisions.

Materials and methods

The seven year trial was established in 2013. Gala trees (clone Royal Beaut) were sourced from specialist nurseries Fleurens (Standard Knip, 1 year 5 + branches and 1 year unfeathered) and Mazzoni (2 year old grow through)

They were planted in March 2013 in fallow ground on Stumble field at Fruit Advisory Services LLP, Brogdale Farm, Faversham, on soil of a clay loam with flint type.

The trees are supported on a post and wire system with bamboo canes at planting distances of 3.5m by 0.8m.

The trial area consists of a randomized complete block with each of the five growing systems replicated in six blocks (rows):

Twin Stem	2 year old grow through	1 Year 5 + branches	1 year unfeathered	Standard Knip	1 year unfeathered
2 year old grow through	1 Year 5 + branches	Standard Knip	2 year old grow through	1 year unfeathered	Twin Stem
1 year unfeathered	Twin Stem	2 year old grow through	Standard Knip	1 Year 5 + branches	Standard Knip
1 Year 5 + branches	Standard Knip	1 year unfeathered	Twin Stem	2 year old grow through	1 Year 5 + branches
Standard Knip	1 year unfeathered	Twin Stem	1 Year 5 + branches	Twin Stem	2 year old grow through
Block 1	Block 2	Block 3	Block 4	Block 5	Block 6

Figure 1. Block layout.

Each row has one plot of each growing type consisting of 10 trees per plot, making 300 trees in total on approximately 0.09ha. Eight trees will be used in each plot for recording and sampling and the end two trees in each plot will be guards.

	1 guard tree	8 trees used for recording	1 guard tree	
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Figure 2. Plot layout.

The five different tree types ('treatments' or 'planting methods') selected were:

1. Standard Knip tree
2. 1 year 5 + branches tree
3. 1 year unfeathered tree
4. 2 year grow through tree
5. Twin stem tree

During 2013 the trees were pruned minimally to remove excess branches (any that were too strong or too weak). Any fruit produced in 2013 was removed in order to ensure that the trees established well.

Plots will be monitored regularly during 2014 and the shoot regrowth assessed from around the middle of May to establish the 9 leaf stage. Twenty shoots per treatment plot will be counted, 10 shoots from either side of the plot from all 10 trees.

The first pruning of the Fruit Wall will be carried out in 2014 when the shoot extension growth has expanded to 9 leaves. The branches will be cut back to a maximum length of 40cm at the base of the tree and 20cm at the apex (each side, giving a total width per tree of 80cm and 40cm).

The date of all pruning cuts will be recorded and photographs taken before and afterwards.

In subsequent years pruning will also be done at this 9 leaf stage and photos taken before and afterwards.

Any necessary summer pruning/husbandry and thinning will also be carried out from 2014.

Each year from year 2 to year 6 the total fruit weight will be recorded from the eight trial trees in each plot. A random selection of 100 fruits from each plot will be measured for fruit size and quality (Class 1; Class 2 and reject). Harvest date will be according to industry guidelines (Quality Fruit Group). Photographs of each tree type at harvest will be taken.

Post harvest tree volume will also be calculated from height and spread measurements in 2104.

Fertiliser and routine applications for pests and disease were applied throughout 2013 by the Brogdale Farm staff under the supervision of Nigel Baker, Farm Manager.

A review will be made at the end of the 2017 season to establish whether full cropping has been achieved.

Assessments

No assessments were required to be taken during the establishment phase.

Estimated time line for records and assessment for subsequent years:

- 30 June 2014 Growth stage recorded and trees pruned
- 31 Oct 2014 Yield, quality and tree volume recorded
- 30 June 2015 Growth stage recorded and trees pruned
- 31 Oct 2015 Yield, quality and tree volume recorded
- 30 June 2016 Growth stage recorded and trees pruned
- 31 Oct 2016 Yield, quality and tree volume recorded
- 30 June 2017 Growth stage recorded and trees pruned
- 31 Oct 2017 Yield, quality and tree volume recorded
- 30 June 2018 Growth stage recorded and trees pruned
- 31 Oct 2018 Yield, quality and tree volume recorded

Results

No results were recorded during the establishment phase of the trial.

Discussion

Not applicable.

Conclusions

Establishment during 2013 was satisfactory.

Knowledge and Technology Transfer

There were no results to present or technology to transfer for the 2013 season.

Results from the 2014 season may be presented at the:

- FAST LLP growers' conference in February 2015.
- 2015 HDC Tree Fruit Review.
- EMRA/HDC Tree Fruit Day in 2015.

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Appendix 1

2014 Update

Shoot growth stages were assessed on:

- 19 May – mean overall leaf count approximately 6
- 28 May – mean overall count 6.5, individual tree type counts:
 1. Standard Knip 6.5
 2. 1 year 5 + branches 6.7
 3. 1 year unfeathered 6.4
 4. 2 year grow through 6.5
 5. Twin Stem 6.4
- 10 June – mean overall count 9.1, individual tree type counts:
 1. Standard Knip 9.1
 2. 1 year 5 + branches 9.3
 3. 1 year unfeathered 8.9
 4. 2 year grow through 9.0
 5. Twin Stem 9.1

The Fruit Wall was pruned at the 9 leaf stage on 13 June 2014. Hand pruning was carried out simulating a mechanical cut.

Thinning was carried out during the week beginning 16 June 2014.

Summer husbandry was carried out on 23 June 2014.

Appendix 2

Photograph series of stages



Figure 3. Photograph series 1. Standard Knip - plots before 9 leaf cut, after 9 leaf cut and after thinning.



Figure 4. Photograph series 2. 1 Year 5 + branches - plots before 9 leaf cut, after 9 leaf cut and after thinning.



Figure 5. Photograph series 3. 1 Year unfeathered - plots before 9 leaf cut, after 9 leaf cut and after thinning.



Figure 6. Photograph series 4. 2 Year old grow through - plots before 9 leaf cut, after 9 leaf cut and after thinning.



Figure 7. Photograph series 5. Twin Stem - rows before 9 leaf cut, after 9 leaf cut and after thinning.