Grower Summary

TF206

Planting material for fruit wall orchard systems for apple

Grower Summary 2018

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Project Leader:	Tim Biddlecombe Fruit Advisory Services Team LLP Brogdale Farm Brogdale Road Faversham Kent ME13 8XZ
Contractor:	Fruit Advisory Services Team LLP
Industry Representative:	Mark Holden Adrian Scripps Ltd Moat Farm Five Oak Green Tonbridge Kent TN12 6RR
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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.

GROWER SUMMARY

Headline

- 2017 was the fourth fruiting year and results showed that the 2 Year Old trees again had significantly higher annual yield and also the highest cumulative yield.

Background and expected deliverables

Growers in many countries are actively looking for ways to reduce labour inputs and increase the use of mechanical aids in a range of fruit crops. With a general decline in skilled labour, ease of management is another requirement, but in all these developments it is essential that there is no loss of yield or quality. In fact, an increase in yields will be required to enable growers to maintain profitability.

Following the successful development and commercial uptake of the Concept Orchard (AHDB Horticulture Project TF 151) by many UK growers, further evolution and development of more intensive planting systems is being considered. In TF 151, reference was made to 'Le Mur Fruitier', a newly developed orchard system in France. Further developments of this system have been carried out privately and 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 generally on varieties not grown in the UK. Results have shown that the principles developed in the work by CTIFL in France can apply in more northern growing areas. However, they need to be adapted to local growing conditions and varieties, as the timing of pruning is critical and specific to individual varieties, whilst the length of the growing season varies in different geographical areas.

Little work has been done on ways of establishing Fruit Wall orchards and which type of tree gives the best results. Conventionally produced trees have a form and structure ideally suited to wider spacings, where a branch framework is necessary, but they can be adapted to be managed in a Fruit Wall planting. However, other tree types may be more suitable, 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.

Several specialist nurseries are 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 project will

provide a comparison of five different tree types using a standard variety/ rootstock and spacing, and provide growers with comparable data to allow them to make informed decisions about the best tree type to use for their own situation.

Summary of the project and main conclusions

Trees were planted and established during 2013. Gala trees (clone Royal Beaut) were sourced from specialist nurseries. The trees were planted in March 2013 at Brogdale Farm, Faversham. The site (soil type: clay loam with flint) had been fallow for at least 10 years. The trees were planted at a distance of 3.5m by 0.8m (except Twin Stem at 1.6m).

The trees were not irrigated during establishment and have not been irrigated during the trial. A standard commercial programme for management of pest and disease, nutrient requirements and foliar feed sprays plus herbicides has been applied since establishment.

The five different tree types selected were:

1. 1 Year 5 + Branches
2. 1 Year Unfeathered
3. 2 Year Old (grow through)
4. Standard Knip
5. Twin Stem

The trial area consists of a randomized complete block with each of the 5 growing systems replicated in 6 blocks (rows):

Table 1. Trial plan.

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**

All of the trees were supplied by specialist nurseries in the Netherlands except for the Twin Stem trees, which came from a nursery in Italy. The Dutch trees were grafted onto the dwarfing rootstock M9 (Clone 337), with an equivalent dwarfing rootstock used for the Italian Twin Stem trees.

Each row has 1 plot of 10 trees of each tree type (except for twin stems which have 5 trees but 10 stems), making 300 trees in total on an area approximately 0.09 ha. The middle 8 trees (3 trees for twin stems) were used for recording and sampling and the end 2 trees (1 for Twin Stems) in each plot were guards.

Table 2. Plot layout – except Twin Stems:

	1 guard tree	**8 trees used for recording**	**1 guard tree**

Table 3. Plot layout – Twin Stems:

	1 guard tree	**3 trees used for recording (6 stems)**	**1 guard tree**

During 2013 the trees received minimal pruning by hand to remove excess branches (any that were too strong or too weak) and all fruit was removed in order to ensure that the trees established well.

Growth stages were monitored regularly during early 2016 and shoot growth assessments commenced in May, to establish when to prune at the 9 leaf stage which occurred on 24 June.

Photographs of trees before and after the 9-leaf cut in 2016 cut are included in Appendix 1 at the end of the Science Section of the report.

In July 2016 (after the fruit wall cut), all trees were thinned to 2 fruit per cluster on branches below 1.5m and 1 fruit per cluster on branches above 1.5m. A further quality / crop load thin was also carried out.

Fruit was harvested commencing 12 October 2016 following maturity testing to determine the optimum harvest date, placed into cold store and assessed later for quality and size.

Key results in 2016

- There were statistically significant results in yields – 2 Year Old tree types yielded the most fruit and 1 Year Unfeathered yielded the least fruit.

- Fruit quality in 2016 was good – all tree types achieved over 80% Class 1 except 1 Year 5 + Branches.
- Fruit size in the trial and across the industry in general was small in 2016 due to climatic conditions during fruit development.
- Tree volume decreased for all tree types in 2016. The 2 Year Old trees continue to have the highest volume.

Key results in 2017

2017 was the fourth and penultimate fruiting year.

- There were statistically significant results in yields – 2 Year Old tree types yielded the most fruit and Twin Stem yielded the least fruit.
- Fruit quality in 2017 was again reasonable but affected by frost events at vulnerable growth stages – 1 Year Unfeathered and Standard Knip achieved over 80% Class 1 fruit whilst all other tree types were under 80% and Twin Stem had the lowest of 76.4%.
- Average fruit weight was acceptable in 2017 with all tree types having average single fruit weights of >120g except 2 Year Old (116.5g). 1 Year 5 + Branches had the heaviest average fruit weight of 131.4g.
- Percentage fruit size was acceptable with all tree types having 60% fruit between 60mm and 70mm and <10% fruit under 60mm.
- Tree volume decreased for all tree types in 2017 compared to 2016. The 2 Year Old trees continue to have the highest volume.

Main conclusions to date

2017 was the fourth fruiting year and results showed that the 2 Year Old trees again had significantly higher yearly yield and also the highest cumulative yield. Twin Stem had the lowest yield in 2017 and 1 Year Unfeathered had the lowest cumulative yield. All tree types decreased in volume compared to 2016 but overall yields were greater in 2017 than 2016 for all the tree types and despite damage from frost.

All tree types have reached commercially acceptable Class 1 yields for their age except for Twin Stem. However, Twin Stem had the highest yield efficiency of all tree types.

This trial has demonstrated minimal value to the grower until the fourth fruiting year. However, increased long term returns are possible based on 2017 results and future expected potential yield increases from the best tree type for Fruit Wall systems.

Growers should be able to reduce pruning costs from the reduced labour input required.

Financial benefits

The trees have carried four crops, three of which have been heavy. Most treatments have yielded commercially acceptable marketable quantities with decreased labour inputs in 2017. This trial has so far demonstrated that there is limited potential for increased returns compared to non Fruit Wall managed systems but it is too early to determine conclusive financial benefits. There is potential for reducing pruning costs and skilled pruning labour requirements.

The trial is responding to industry requirements to investigate shortening payback periods and to produce guidance on the cropping potential of different tree types in the early years.

The cost of successfully establishing an intensive orchard is currently up to £28,000 (depending on exchange rates) per hectare (FAST 2018). In particular:

a. The differences in costs of the various tree types available vary depending on type selected and quantity (up to an extra £2.99 per tree or from an extra £165 to £3,300 per hectare - FAST 2018). Some tree types have the potential to increase in volume, vertically and horizontally, much more quickly, leading to increases in early yields.

b. An estimated reduction in yield from a Fruit Wall system of 5% in each of the first four cropping years can reduce net returns by around £3,000 per ha (FAST 2018). However, the actual % reduction for all tree types in the first three cropping years of this Fruit Wall trial has been much greater (up to 87% for 1 Year Unfeathered in 2014 but some of this was due to disease) except for 1 Year 5 + Branches, 2 Year Old and Standard Knip in 2015 (all under 5.5%) - see Table 1. There was improvement in 2017, the fourth cropping year, when three of the tree types yielded more marketable fruit than commercial expectations (1 Year 5 + Branches, 2 Year Old and Standard Knip – between +5.8% and +12.5%). Despite this, based on cumulative marketable yields, the overall reduction in yield for the duration of the trial still falls below this estimate (between -14.3% and -39.8%) - see Table 2. Some of the differences could be attributable to the tree types, orchard and climate conditions. Results from another AHDB funded trial, TF 207 (Determination of the optimum pruning time for fruit wall orchard systems for Gala apple), also demonstrated lower yields than from hand-pruned treatments. Data from 2018 will be added to these calculations in the final report.

Table 1. Percentage difference of yearly Fruit Wall yields compared to commercial

expected yields (25, 35, 45 & 45 t/ha respectively) – shaded cells indicate similar to or greater than estimated Fruit Wall reduction of 5%.

TREE TYPE / YEAR	2014	2015	2016	2017
1 Year 5 + Branches maider	-75.0	-4.4	-30.3	12.5
1 Year Unfeathered whip	-87.1	-32.6	-48.5	-10.2
2 Year Old	-67.9	0.5	-21.4	11.1
Standard Knip	-77.5	-5.3	-25.1	5.8
Twin Stem	-82.4	-21.4	-41.6	-19.1

Table 2. % difference of cumulative Fruit Wall yields compared to commercial expected yields.

TREE TYPE / YEAR	2014	2015	2016	2017
1 Year 5 + Branches maiden	-75.0	-33.8	-32.3	-18.9
1 Year Unfeathered whip	-87.1	-55.3	-52.4	-39.7
2 Year Old	-67.9	-28.0	-25.2	-14.3
Standard Knip	-77.5	-35.4	-31.0	-19.9
Twin Stem	-82.4	-46.8	-44.6	-36.9

c. New intensive orchard systems are simpler and easier to prune than lower density traditional orchards. Depending upon planting distance and hand pruning equipment used, it takes approximately 34 hours (4.5 days) to hand prune one hectare of mature orchard (FAST 2017) compared to three hours for mechanical pruning or a difference of £420 per hectare (Adrian Scripps Ltd 2017). Hand pruning speed is improved if electronic secateurs are used, but these cost around £2,000. Younger trees such as those in this trial would take less time to hand prune (eg three days). Some hand pruning will be needed (eg inter pruning) even where mechanical pruning is used, but net savings of around £6,300 per ha over a 15 year orchard life are envisaged (excluding machinery costs).

d. Anecdotal evidence from experimental plots in Northern Europe suggests that annual yields from Fruit Wall plantings can be around 20 t/ha greater than orchards of a similar density managed conventionally. Mika et al (2016) have recorded an 11.5% increase in yields from mechanically pruned compared to hand pruned trees which would equate to 50 t/ha versus 45 t/ha respectively. The value to the grower of a 5 t/ha increase would be approximately £31,000 net of all post harvest costs over 15 years. In 2017 tree types 1 Year 5 + Branches, 2 Year Old and Standard

Knip achieved marketable t/ha of 50.6, 50.0 and 47.6 respectively - see Table 3. This equates to up to between 12.5%, 11.0% and 5.8% yield increases compared to commercial standard trees of the same age. See Table 1.

Table 3. Marketable yields t/ha per year including standard commercial expectations and 5% expected reduction for Fruit Wall management – shaded cells indicate where Fruit Wall yields have equalled or exceeded standard commercial expectations.

TREE TYPE / YEAR	2014	2015	2016	2017
1 Year 5 + Branches maiden	6.2	33.5	31.4	50.6
1 Year Unfeathered whip	3.2	23.6	23.2	40.4
2 Year Old	8.0	35.2	35.4	50.0
Standard Knip	5.6	33.1	33.7	47.6
Twin Stem	4.4	27.5	26.3	36.4
Standard commercial	25	35	45	45
Standard commercial - 5%	23.75	33.25	42.75	42.75

e. For growers to implement the system they would have to rent or buy specialist pruning equipment. Current costs for this type of equipment are approximately £16,750 (Seymour 2017), but the machine could also be used for other operations on the farm such as hedge and windbreak cutting and could also be rented out.

f. Continued good technology and knowledge transfer will be needed and possibly further adapted developmental work. This is because the interaction between the Fruit Wall growing system and other orchard management operations (such as use of growth regulators for fruit setting and thinning) could well be different (possibly due to the effects of late pruning on leaf metabolism at a critical time of year during the early fruit development phase). As the leaf to fruit ratio is altered in the Fruit Wall, more attention to crop nutrition and leaf health will be necessary.

Action points for growers

2017 was the fourth fruiting season of the trial. Some significant effects for some parameters are now likely, due to the prolonged Fruit Wall management rather than tree type alone. Cropping wood is increasing within the canopy despite reduced tree volume.

- The Fruit Wall cut was made when nine new leaves had emerged on the current season's growth. Growers regularly need to make random leaf counts to establish the growth stage before making the cut.

- Inter tree pruning was carried out on the trial trees for the first time in spring 2017. Requirements must be considered, and trees will need pruning regularly once grower orchards reach maturity. Only one or two cuts per tree should be required if management is maintained.
- Irrigation is critical at high planting densities, otherwise fruit size and quality may deteriorate. Growers will need to maintain adequate irrigation especially during low rainfall / higher than average temperature seasons, to ensure adequate fruit size and maintain sufficient regrowth. Extra fertigation and mulching should also be considered, in particular for any weak orchard areas.
- Fruit Wall managed trees have a narrow profile and may be suited to growing in narrower alleyways such as 3.0 m rather than 3.5 m, as in this trial. Growers may consider increasing the density in this way for newly planted orchards, which would increase trees per hectare (from 3,571 to 4,167) and to maximise the yield efficiency of orchards managed under the Fruit Wall system.

Other actions points will be determined after the 2018 season when conclusions are made as to the most suitable tree type for Fruit Wall management in terms of early yield build up, highest t/ha and yield of Class 1 fruit plus optimum returns. Results to date suggest that 2 Year Old, 1 Year 5 + Branch and Standard Knip trees are leading in this regard. The difference between the highest yielding tree type per hectare (2 Year OId) and 1 Year Unfeathered (the lowest) is similar over the last four years. The yield difference between 2 Year Old and Twin Stem is increasing. However, there may be scope for planting Twin Stem and 1 Year Unfeathered trees at higher density (narrower alley width) or converting established orchards to the Fruit Wall management system, since they have higher yield efficiency compared to other tree types.

