



# Grower Summary

## **TF 207**

Determination of the optimum  
pruning time for fruit wall  
orchard systems for Gala apple

Final 2017

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## **GROWER SUMMARY**

### **Headline**

- Higher yields were achieved from hand pruning treatments than from mechanically pruned treatments in this fruit wall pruning trial, although labour savings are available from integrated use of mechanical pruning.

### **Background and expected deliverables**

Apple growers are continually trying to reduce labour costs in their production systems to remain commercially viable, whilst aiming to increase yield and improve fruit quality. The fruit wall production system, where pruning can be carried out in part using hedge type cutters, is one possible solution. Research into mechanical pruning of fruit walls has already been done in mainland Europe and particularly in Belgium and France, where the concept of fruit walls originated. However, the positive recommendations developed there need to be assessed and adapted in other countries and regions where growing conditions and varieties differ.

The exact timing of the pruning cut determines the amount of vegetative regrowth and also whether the bud behind the cut becomes floral or remains vegetative. Determining the optimum time to make the pruning cut will help to achieve maximum productivity from the fruit wall system.

This trial was set up to determine the optimum time to mechanically prune orchards planted as a fruit wall, compared to a winter hand pruned control. The effects of inter pruning versus non-inter pruning were also examined. The trial was conducted over five years to assess the long term effects of the treatments.

### **Summary of the project and main conclusions**

The trial was established in 2012 in an existing high density commercial orchard of the apple variety Gala (Galaxy clone), planted in the winter of 2009/10 on a clay loam soil at Parsonage Farm, Cobham, Kent, by kind permission of Adrian Scripps Ltd.

The trees were trained on a post and wire system with bamboo cane supports at a planting distance of 3.5 x 0.5m (5,714 trees per hectare) with 10 trees between each post, forming a bay, and each plot consisting of two bays. The trial area comprised 800 trees in 20 bays of 10 trees in each of four blocks. Each plot consisted of 20 trees: 6 guard trees at each end and 8 trees used for sampling and recording.

Conventional winter hand-pruning was compared with mechanical pruning using a tractor mounted cutter bar, at four different growth stages; pink bud and when extension growth had produced 6, 9 or 12 new leaves (or when 50% terminal buds were present). Each of these treatments was carried out either with or without inter-tree hand-pruning, which was done at the same time as the winter pruning treatment. Mechanical pruning began in 2012 and finished in 2016, with the first inter-tree pruning starting in 2012/13 and concluding in 2015/16.

### ***Results for 2016***

As in previous years, the winter and early season cuts produced the strongest regrowth (approximately 35cm) and the latest timing the least regrowth (approximately 11cm). Later cuts controlled growth better.

Yields were lower in 2016 and there were statistically significant differences between the treatments but the Winter Hand control still had the highest cumulative yield. Cumulative yield was reduced for later pruned treatments, except for 9 Leaf Non Inter Pruned (NIP).

Over 85% Class 1 was recorded for all treatments except 6 Leaf Inter Pruned (IP) and was highest for Winter NIP. IP lowered Class 1 percentage except for 9 and 12 Leaf.

Small increases in fruit size/weight were again recorded in the IP plots and results were statistically significant but fruit size and weight were generally reduced in 2016.

Fruit colour was poor in 2016. Later NIP treatments significantly improved colour. However, from the sub sample of fruit assessed, only Winter Hand IP, 6 Leaf NIP, 9 Leaf NIP and 12 Leaf NIP had an average of above 60% red colour.

There were no significant differences in maturity (starch) at harvest.

BRIX<sup>o</sup> levels for all treatments in 2016 were >12 at harvest (when average starch was 90-95%). There was a significant reduction of fruit sugar levels in the later summer cuts.

Fruit firmness values between treatments were very similar.

There were no significant differences between treatments for leaf or fruit nitrogen, but levels in earlier mechanically pruned plots were higher than the later cuts.

Lower than average rainfall from July to October, higher than average temperatures in August and September and high night time temperatures leading up to harvest may have contributed to the lower yields, smaller fruit size and poor colour in 2016.

A more comprehensive report of the results of the 2016 season can be read in the Science Section of this report.

## ***Overall results and conclusions from the whole project 2012 – 2016***

### ***Pruning timing***

Pruning dates varied considerably between 2012 and 2016 depending on the earliness of the season. The number of days between pink bud and the 12 leaf stage varied from 55 days in 2016 to 68 days in 2013.

### ***Vegetative regrowth***

In every year of the trial, the later pruned treatments had significantly less regrowth. After 2014, a trend developed where the shoot growth in the non-inter pruned (NIP) was significantly shorter than the inter pruned (IP).

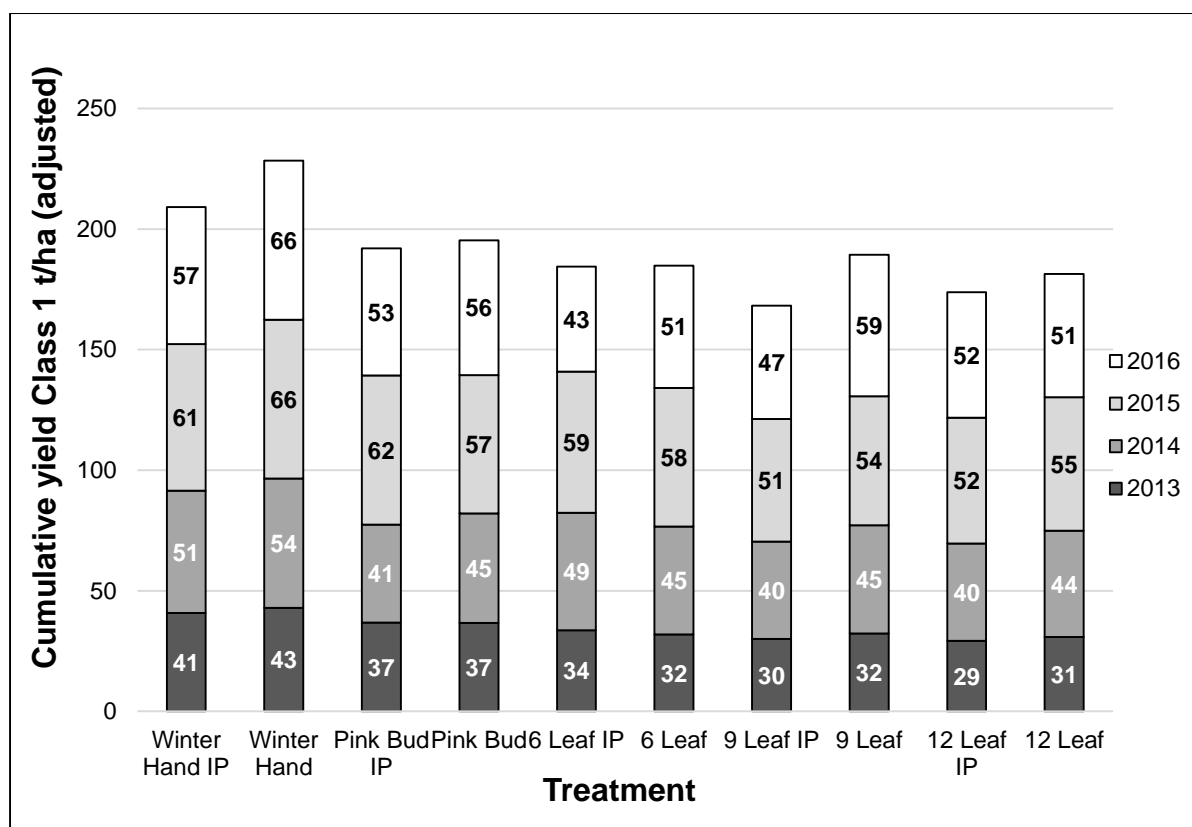
### ***Yield per tree***

There were significant differences for average yield per tree in three of the five years recorded. NIP trees were displaying higher yields towards the end of the trial.

The Winter Hand Pruned NIP produced the highest yields in every year recorded, but by 2016, the Pink Bud IP, Pink Bud NIP and 9 leaf NIP treatments had statistically similar yields to the Winter Hand Pruned IP treatment.

### ***Yield per hectare***

The Winter Hand Pruned NIP treatment had the highest cumulative yield over the trial followed by the Winter Hand Pruned IP and Pink Bud NIP. Both Winter Hand treatments yielded more Class 1 fruit than any other treatments (Figure 1).



**Figure 1.** The effect of pruning treatments on cumulative yield per treatment – Class 1 t/ha adjusted for % pollinators and diseased trees within trial section of the orchard.

### ***Fruit weight and diameter***

There were only significant effects of treatment on fruit weight and diameter in 2013, 2014 and 2016. In 2013 and 2014, the later pruned and inter pruned treatments produced larger fruit.

### ***Fruit colour***

All pruning treatments had sufficient colour to meet Class 1 standards in every year except 2016.

### ***Fruit quality and maturity***

There were no statistical differences in fruit starch levels between treatments in any year of the trial. Fruit sugar content was below BRIX° 12 for all treatments in every year apart from 2012. This is below the commercially acceptable standard. Although there were significant differences in sugar content in every year, the results showed no consistency.

### ***Fruit firmness***

There were no significant effects on fruit pressure in any year of the trial except in 2012, when Pink Bud had statistically higher pressure than any other treatment.

### ***Mineral analysis***

Mineral analysis on fruit was conducted in 2012, 2013 and 2014. The only significant difference between treatments occurred in 2014 when significantly higher P levels were noted in the Pink Bud IP treatment. The mineral levels were adequate for long term storage until April.

### ***Leaf analysis***

Leaf analyses were conducted in every year from 2013 until 2016. There were significant differences in every year between treatments but these were not consistent from year to year. In 2015 and 2016, a trend showing higher leaf nitrogen in Winter Hand Pruned and earlier mechanical cut treatments developed, but these were not significant.

### ***Fruit dry matter***

Dry matter content (DMC) was only measured in 2015 and 2016. The only significant differences were found in 2016, where the Winter Hand, Pink Bud and IP sub treatments had higher dry matter. All treatments had above 12% DMC.

### ***Conclusions***

- New intensive orchard systems are simpler, easier and cost less to prune than lower density traditional orchards. Irrigation is critical at high planting densities otherwise fruit size and quality may deteriorate.
- Winter Hand treatments continuously had higher yields than any mechanical cutting treatment although Pink Bud and 9 Leaf NIP were similar alternatives. The trial orchard was not vigorous and it should be noted that differences in growth response and yield could be much greater in orchards that are stronger.
- Percentage of Class 1 fruit was acceptable in all years.
- Starch and fruit firmness were not affected by any of the treatments and dry matter accumulation was acceptable in the two years tested. BRIX<sup>0</sup> levels were generally low in all years but it should be noted that fruit in the trials section was harvested earlier than the rest of the orchard and sugars would improve in store.
- Varying levels of leaf and fruit minerals (from analyses) did not appear to have any detrimental effect on treatments.



- Over the period of the trial, as the trees responded to the mechanically pruned treatments, more fruiting wood developed and the trees became better furnished resulting in increased cropping within the narrower tree canopy. It should be noted that cumulative yields were still highest at the end of the trial in the hand pruned trees.
- Inter-tree pruning generally led to slightly more growth and lower yields.
- It is important to judge when to prune by a definitive growth stage rather than by a calendar date. Growers and their staff must assess trees and orchards each year and understand the implications of the degree and the timing of pruning management, in terms of effects on yield, growth and fruit bud development. The timing of mechanical pruning should be based on the needs of the orchard rather than pruning at a prescribed time each season.
- In strongly growing orchards and where tree vigour control is important, it could be better to delay mechanical pruning to the 9 or 12-leaf stage.
- Where limited regrowth and improved fruit bud formation are required, pruning at the 9-leaf stage appears to be best.
- Where trees are not vigorous and are in balance, pruning at Pink Bud may benefit fruit size and sugar content, but this will encourage more growth.
- Growers will need to weigh up the benefits of the increased cumulative yield from winter hand pruning early in the life of a fruit wall against any labour savings from mechanical pruning.
- Further work may be useful in order to assess how to further adapt, develop and implement mechanical pruning as part of a husbandry management programme and to test it on other varieties.

## **Financial benefits**

The harvest in 2016 was the fifth picked from the orchard planted in the winter of 2009/2010. Annual yields in the commercial orchard have followed the expected levels of an establishing Gala crop in the UK (ie.50 t/ha by year 7). The yields in 2016 were lower than those in 2015 in every treatment except 9 Leaf NIP.

At the planting distance of trees in this trial (0.5m) it would take approximately 46 hours (7.5 days) to hand prune one hectare of orchard (FAST 2017) compared to three hours for mechanical pruning (Adrian Scripps Ltd 2017). Mechanical pruning therefore offers a labour saving of 43 hours per hectare.

At the planting density of the orchard in this trial (5,714 trees/ha) the total commercial cost of pruning would be around £451 per hectare (approximately £0.08 per tree to mechanically cut

and for inter and top pruning by hand (Adrian Scripps Ltd 2017). Realistically, trees would not be planted at this spacing unless specifically for fruit wall management – at such high densities orchards can only be machine pruned. Therefore, financial comparison must be made with a lower density orchard (eg. 2,575 tree/ha) where the commercial cost of hand pruning trees would be £515 per hectare (£0.20 per tree for base and top pruning by hand – Adrian Scripps Ltd 2017). A saving of £64 per hectare could be made on pruning costs for a fruit wall managed orchard.

For growers to implement mechanical pruning, they would have to rent or buy specialist pruning machinery. 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 pruning the tops of conventional hand pruned plots. It could also be rented out or shared with other local growers.

Anecdotal evidence from experimental plots in Northern Europe suggested that annual yields from fruit wall plantings could yield around 20 t/ha more than orchards of a similar density managed conventionally. However, in Poland, Mika et al (2016) have recorded only an 11.5% increase in yields from mechanically pruned compared to hand pruned trees which would equate to, for example, 50 t/ha versus 45 t/ha respectively. Conversely, a reduction in yield of 5% from a fruit wall system in each of the first four cropping years can reduce net returns. In this AHDB trial, during the first five cropping years, the Class 1 yield reductions in the mechanically pruned treatments compared to hand pruned were much larger than the 5% originally expected. Reductions from 16% (Pink Bud) to as much as 26% (9 Leaf IP) were recorded (see Table 1). These yield losses are considerable and undermine the financial viability of the fruit wall model used in this trial, despite the (minimal) reduction in pruning costs. The yields of all mechanically pruned treatments remained lower than the standard winter pruned plots in each year of the trial and the yield gap has shown no consistent or substantial signs of closing (except for Pink Bud NIP which had the lowest total % loss). For example, the yield reduction for 6 Leaf IP compared to Winter Hand NIP was -22% in 2013, -9% in 2014 but -34% in 2016. Similarly, Pink Bud IP was -24% in 2014, -6% in 2015 but -20% in 2016.

It must be noted that these yield reductions may well be due to the rigid timings of the fruit wall cuts set out in the trial protocol and followed every year. In reality, a grower would have the flexibility to accurately time any fruit wall cut based on the needs of the orchard and depending on the seasonal conditions rather than mechanically pruning every year at a prescribed time (eg every year at pink bud or at a certain leaf stage) or alternatively decide not to prune at all in a season or only conduct inter pruning, if appropriate. Therefore cropping potential may well be enhanced if fruit wall cuts were timed carefully to the actual needs and growth rates of the orchard. Therefore, any yield reductions of orchards managed using fruit wall methods as

part of a bespoke husbandry programme compared to conventionally pruned orchards could be decreased or negated and financial benefits enhanced.

**Table 1.** Percentage Class 1 yield reduction (compared to Winter Hand) per treatment per year and total over 5 years.

<b>Treatment/Year</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>Total</b>
<b>Winter Hand IP</b>	0%	0%	0%	-5%	-5%	-8%	-14%	-7%
<b>Winter Hand</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>
<b>Pink Bud IP</b>	0%	0%	-26%	-14%	-24%	-6%	-20%	-17%
<b>Pink Bud</b>	0%	0%	-26%	-15%	-15%	-13%	-15%	-16%
<b>6 Leaf IP</b>	0%	0%	-20%	-22%	-9%	-11%	-34%	-19%
<b>6 Leaf</b>	0%	0%	-20%	-26%	-17%	-13%	-23%	-19%
<b>9 Leaf IP</b>	0%	0%	-23%	-30%	-25%	-23%	-29%	-26%
<b>9 Leaf</b>	0%	0%	-23%	-25%	-16%	-19%	-11%	-18%
<b>12 Leaf IP</b>	0%	0%	-33%	-32%	-25%	-21%	-21%	-25%
<b>12 Leaf</b>	0%	0%	-33%	-28%	-18%	-16%	-23%	-22%

## **Action points for growers**

### **2016 Results**

- It is important for growers to assess their orchards and trees before deciding on the timing of pruning.
- Where tree control is the major consideration delayed pruning is advised.
- Whilst in 2016 Winter Hand produced the highest yields, for Fruit Wall management the 9 Leaf NIP appears to be the optimum Fruit Wall timing (highest yields and best grade out compared to other timings in 2016).
- Where improved fruit size is required, inter pruned trees have an advantage.
- For improved colour later cuts without inter pruning appear to be the optimum.
- Adequate irrigation and consideration of colour improving products in high risk years should be considered to maintain size and quality.
- Amelioration for low P, K, Ca and Mn may be required if choosing to prune after Pink Bud.

### **Whole trial results**

- Mechanical pruning could be a valuable alternative management tool when employed as part of a customised husbandry programme.
- Mechanical pruning can be used instead of hand pruning in years where time is limited, labour shortages occur, where there are prolonged poor or challenging weather conditions and as an occasional cost saving exercise.
- Growers must assess their orchards for quantity, quality and position of fruit bud, growth habit and shade and consider their requirements before deciding whether and when to mechanically prune.
- Growers may consider mechanically pruning at different growth stages each year according to the orchard's vigour and needs (and as advised by their agronomist).
- Growers need to regularly make random leaf counts on current season's extension to establish the optimum growth stage before any mechanical pruning.
- Inter tree pruning requirements should be considered and will need to be done regularly once new orchards reach maturity and for converted orchards. Only one or two cuts per tree may be required.
- Irrigation is critical at high planting densities otherwise fruit size and quality may deteriorate. Growers will need to ensure 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 areas.

- Growers should take regular leaf samples and be prepared to apply some foliar feed for micro and macro nutrients as required including amelioration for low P, K, Ca and Mn if choosing to prune after early cuts.
- Later mechanical pruning may reduce BRIX<sup>0</sup> and dry matter which will need to be considered by growers with low BRIX<sup>0</sup> / dry matter orchards planning on using the system as part of their pruning strategy.
- The narrow profile of mechanically pruned orchards may be suited to narrower alleyways. Growers may consider increasing the density and trees per hectare for newly planted orchards and maximise the yield efficiency of orchards managed under the Fruit Wall system as part of an integrated approach.