



Stone Fruit Thinning: a Desk Study of Recent Developments Overseas

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Produced by

Chris Nicholson

ADAS UK Ltd



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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 with detail and 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.

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Introduction and scope of review

Erratic cropping of stone fruit is a perennial problem in the UK, particularly in plum orchards. In recent years the need to produce consistent yields of regular sized fruit to meet supermarket specifications has become the top production efficiency target. Key to achieving acceptable fruit size and quality is flower number control. Over time, blossom and fruitlet thinning chemicals have been trialled for regulating fruit size, but have had limited success. The most widely adopted chemical blossom thinner has been Ammonium thiosulphate (ATS) but differences in the timing of application, weather conditions and rate of application have led to variable results. In general crop yield is not as consistent or reproducible as fruit growers require. Chemical thinning is often followed by hand thinning, which is an added and substantial cost. Some stone fruit growers use repeated rounds of hand fruitlet thinning to achieve the optimum crop load but this comes at considerable expense. Techniques and equipment that could consistently and cost-effectively thin stone fruit crops would be welcomed by UK stone fruit growers and could lead to renewed interest for increasing the planted area of stone fruit crops.

Techniques for thinning stone fruit have been developed overseas, particularly in countries that grow peaches, a crop which consistently over-sets fruit. Much of the development work has taken place in North America and mainland Europe. In these areas techniques which have been used to thin blossoms include high pressure water jets, compressed air jets and flailing chains, but these approaches have largely ceased because of perceived health and safety risks.

In recent years, the Darwin string thinner has been developed and used to thin fruit buds and blossoms in North America and Europe. The Darwin thinner has a central shaft with a single spinning spindle with cords which can knock out fruiting buds, blossoms or flowers. The Bonner thinner is similar, but has three adjustable arms holding spinning spindles and cords, and is designed to thin a range of tree structures. Hand held mechanical thinners are also being developed, whilst chemicals with the potential to thin flowers and fruitlets are being trialled.

In the UK only plums consistently over-crop and require thinning approaches to optimise yield. This review will cover the main developments for mechanical and chemical techniques for blossom and fruitlet thinning and their suitability for use in commercial UK orchards.

1. Mechanical stone fruit thinning

In recent years most stone fruit thinning research work has been conducted in Europe and North America. The following four systems have been trialled:

1. Darwin string thinner
2. Drum shaker thinner
3. Bonner thinner
4. Hand held thinner e.g. the 'Electro'flor'

1.1 Darwin string thinner

In the 1990s, Hermann Gessler, a fruit grower in the Bodensee area of Germany developed and patented a thinning machine known as the Darwin (Figure 1).



Figure 1. Darwin string thinner

The Darwin is now widely used in commercial orchards in Europe to thin apples grown on the Fruit Wall System and some are in use in the UK. In North America the Darwin has been used to thin peach orchards and has been assessed in comprehensive trials in recent years.

Further reading: <http://www.fruit-tec.com/>

In North America a multi-state project, including Washington State and Penn State Universities called the 'Innovative Technologies for Thinning Fruit' project, has trialled the Darwin string thinner. It has been tested in replicated trials in peach, nectarine and apricot orchards for three seasons. In all cases, the cost incurred to mechanically thin was less than the cost to thin blossom by hand or thin green fruit on trees that had not previously been blossom thinned. When compared to green fruit thinned trees, final fruit size was more often significantly larger in Darwin bloom thinned trees. When compared to hand blossom thinned trees, final fruit size was most often equal or only slightly larger in Darwin thinned trees. Distribution to larger premium sizes was recorded in the majority of trials.

There is very little other published data on plum thinning trials conducted in North America in recent years except a comment by the University of California that the Darwin had not worked well on plums. In other reports on plum thinning it appears that the Darwin was used on large un-pruned trees which were not suitable and gave uneven thinning.

Further reading:

<http://jenny.tfrec.wsu.edu/wtfr/core.php?rout=displtxt&start=120&cid=551>

In Europe the Darwin was trialled in apple orchards in Germany in 2008 and 2009. The results showed that trees thinned by the Darwin had about the same number of apples as the hand thinned trees, which was about half the number of apples on the un-thinned control.

In mainland Europe, just like in the UK, the market is demanding large plum fruits and so orchards are being thinned. In Southern Germany and Switzerland research establishments have been conducting thinning trials in response to cooperatives in these regions trying to establish a market for plums for fresh consumption. At an open day at Breitenhof, the stone fruit research centre in Switzerland, results of plum thinning trials were presented. It was reported that whilst blossom thinning by the Darwin had been extremely effective it could only be used on narrow trees grown on the fruit wall system and not traditional larger trees.

The manufacturers, Fruit Tec, are currently selling 100 – 200 Darwin machines a year. In the UK, it is available for sale through NP Seymour (www.npseymour.co.uk).

Fourteen Darwins are currently in use in the UK, mostly to thin apple crops. A guide price in the UK for a Darwin and all its fittings is £7,500.

Further reading: http://www.fruitmagazine.eu/en/best_en.html - Choose 2009 issue

1.2 Drum shaker thinner

In North America a drum shaker thinner developed from a citrus harvester has been used to thin peach fruitlets (Figure 2). Recently more successful prototype drum thinners have been developed from blackberry harvesters.



Figure 2. The drum shaker thinner

The USDA spiked drum shaker was tested in peach orchards at 35 days after full bloom. This machine has shown promise as a green-fruit-removing machine in studies conducted by USDA horticulturist Steve Miller. Across all trials the spiked drum shakers removed an average of 37% green fruit. The Darwin reduced crop load by 21 to 50%. The literature does not include information on any trials where the spiked drum shaker has been used on plums. It may not be possible to extrapolate the results on peach trees to the potential on plum trees because the

structure of plum trees is different to peach trees. Also there is a difference between the peach and plum fruitlet stalk so the machine may perform differently on plums.

Further reading:

<http://naldc.nal.usda.gov/download/49302/PDF>

1.3 Bonner thinner

The Bonner thinner was developed at the University of Bonn in Germany by Dr. Michael Blanke. It has three rotating arms with cords that can reach into the canopy at various angles (Figure 3). The machine has been tested in Germany and other countries for several years on plums, peaches, cherries, apples, and pears. It is now commercially available through Mueller & Sohn Spezialmaschinen GmbH, Rohrbergstrasse 2, 65343, Eltville, Hessen, Germany.

Some of the cords on the rotating arms can be removed, depending on the desired amount of thinning, which makes it very versatile. It can be used with any spindle type training systems, slender spindle or super spindle, where the arms can gain access to the branches. Compared with chemical thinning, there's a wider window during which mechanical thinning can be done and the results can be seen immediately, whereas it might take three days to assess the results of chemical thinning. This means that the mechanical thinning can be repeated if necessary.

Further reading: www.mueller-eltville.de

In North America Karen Lewis, regional field specialist for Washington State University (WSU), has been carrying out mechanical thinning trials. She has been testing the Bonner string thinner from the University of Bonn, the Darwin string thinner and a hand-held string thinner under development at WSU.

She reported that for apples, the Bonner, with its three moveable arms, was more versatile than the Darwin, with its single spindle. All three of the machines removed bloom and reduced the need for follow-up hand thinning. The machines were also tested in stone fruits, and it was shown that mechanical bloom thinning yielded larger fruit than hand-thinning of green fruit alone, and the cost was lower.

Further reading: <http://abe.psu.edu/scri>



Figure 3 The Bonner thinner in use in an apple orchard

According to Dr Michael Blanke his Bonner thinning machine is being trialed in ten countries around the world, including South Africa. In Europe, it has been included in plum thinning trials in Austria, Norway and three sites in Germany. He reports that the main requirement for successful thinning of plum trees by his Bonner machine is that the trees must be younger spindle type trees without any old vertical branches. In a published paper, Dr Blanke reported on plum thinning trials completed in 2009 and 2010 near Bonn. Trees were thinned with the Bonner at full bloom at three

different rotor speeds. Half the thinned trees were then treated again with the thinner ATS (15 L/ha) or an ethylene releasing compound, 35 days after full bloom. The Bonner treatments successfully reduced the number of fruits per branch from 152 to 67-76. Mechanical thinning significantly enlarged fruit mass from 28g in the unthinned control to 30-32g in the Bonner thinned treatments. Additional chemical thinning with ATS and an ethylene releasing compound resulted in no further increase in fruit mass.

The most efficient method of flower removal and fruit mass enlargement was mechanical blossom thinning at 400 rpm, which Dr Blanke stated may provide a suitable replacement for chemical and/or manual thinning. Alternatively, the mechanical blossom thinning could be combined with either chemical and/or manual thinning. Dr Blanke pointed out that stone fruit is more difficult to thin than pome fruit. The Bonner was used to thin Golden Delicious apples in a trial carried out by PCFuit in Belgium during 2008. The Bonner reduced the number of hours required for thinning by 50 % compared to hand thinning. In 2009 comparable results were achieved for Braeburn. The position and rotation speeds of the thinning arms only had a limited effect on the thinning results.

A guide price for a Bonner to be delivered to the UK would be 9,000 Euros.

Further reading: <http://www.hort.purdue.edu/newcrop/acta/blank.pdf>

1.4 Hand held thinner

There is increasing interest in hand held mechanical thinners because they allow a more targeted thinning approach to suit each individual tree shape and to achieve desired crop loads or strategies. They can be used on larger more traditional shaped trees as long as they have been carefully structured and pruned. They could also be used to follow up after a Darwin thinner to carry out targeted thinning. They can be used from the ground or from a platform.

In North America, Washington State University (WSU) has been developing hand held thinning equipment for a number of years. Early prototypes were adapted from commercial weed trimmers. The first prototype had a petrol engine on the pole, but it proved to be too heavy, noisy and difficult to control. A version with a battery on the pole was developed but it lacked power and didn't work very well. A later version which had two batteries in a backpack worn by the worker was more successful.

During collaborative trials in Chile, the WSU handheld thinner overheated early in the project so a handheld thinner, the 'Electro'flor' made by the French company Infaco was procured (Figure 4). The 'Electro'flor' is a battery-operated handheld thinner which has a three metre carbon fibre telescoping pole and is powered by a 48-volt battery system.



Figure 4. The 'Electro'flor' handheld thinner

The Electro'flor was tested on cherries in Penn University trials. Electro'flor treatments at 20 to 50 percent bloom and 70 to 90 percent bloom were compared with hand bud removal, hand bloom removal and hand thinning of fruitlets. While hand bud removal and hand bloom thinning gave the greatest boost in fruit size, the mechanical thinning was as good as hand fruitlet thinning and was much less labour intensive than any of the hand thinning treatments. Hand bud removal took 189 hours per acre, hand bloom thinning took 207 hours and hand fruitlet thinning took 437 hours per acre, compared with only 42 hours for the Electro'flor when used in early bloom. Following the cherry trials it was thought that growers would probably use a

combination of methods. They might use the Darwin first and then follow up with a handheld thinner.

Further reading:

<http://www.goodfruit.com/Good-Fruit-Grower/March-15th-2012/Mechanical-thinning-of-cherries/>

In Europe the 'Electro'flor' was developed in France by the company Infaco, together with called CTIFL, the French research organization in arboriculture. It has been sold in Europe and recently in North America as a tool for thinning flower clusters on fruit trees. The variable speed rotating wire brush on the end of the telescopic pole, cuts flowers at the peduncle without affecting the tree foliage. Trials using the 'Electro'flor' on cherry trees in Europe have shown that its use results in larger fruits and the time of 100 to 150 hours it takes to thin a hectare is less than the time for manual thinning. Trials on apricots also showed that time savings were significant compared to manual thinning. The trials have also shown that some training is required to use the tool effectively.

The 'Electro'flor' has also been trialled in Switzerland at the Forschungsanstalt Agroscope Changins-Wädenswil. In trials on plums it showed that it could reduce the amount of manual labour to thin plums by 25%.

The 'Electro'flor' has been sold in France, Spain and Italy since 2008. So far around 500 machines have been sold, primarily to fruit growers with peach, nectarine and apricot orchards.

In the UK the 'Electro'flor' is available through Agricare of Canterbury (www.agricareuk.com) at a price in the region of £1,150. At the time of writing no machines have been sold in the UK.

Further reading:

<http://www.infaco.com/en/infaco-products/electroflor/electronic-thinner-electroflor.php>

2. Chemical thinning

In North America, Tara Baugher, a tree fruit educator, has worked on chemical thinning of peaches with Jim Schupp, of Penn State Fruit Research and Extension Centre in Biglerville. In 2007, after three years of trials, they concluded that the chemicals were variable in their performance, did not take off enough fruit and didn't consistently cut the need for hand labour for thinning. They found that availability

and efficacy of chemical thinning programmes vary by crop, orchard and season, so hand thinning is often required to adjust crop load for optimal fruit size, quality and to promote return bloom. Hand thinning, along with pruning and harvesting, is among the most labour-intensive orchard practices; consequently, it contributes significantly to fruit production costs.

Tory Schmid also carried out chemical blossom thinning trials on peaches and nectarines at Washington State University in 2009 and 2010. For stone fruit chemical thinning programmes to be cost effective, they must significantly reduce the need for expensive hand thinning and/or increase the yield of large, high quality fruit. In the two year trial, significant reductions in fruit set and increases in fruit size were rare from chemical thinning treatments. Even in cases where treatments produced desired effects, marginal losses in yield efficiency were likely to offset any financial benefits from the programmes. Over ten years of chemical blossom thinning of peaches and nectarines they found that thinning can be achieved by a variety of chemicals, but ATS had been the most consistent performer in the experiments. They concluded that until new chemistries are identified as potential thinners, the merit of ongoing trials in this area seemed marginal. In addition, the best available option for reducing fruit set, and subsequently increasing fruit size, is use of mechanical thinning equipment like the Darwin or Bonner. The researchers felt that even though they were still learning how best to adopt these new mechanical technologies, they offer the benefit of guaranteeing results independent of weather conditions.

Further reading:

<http://jenny.tfrec.wsu.edu/wtfr/core.php?rout=displtxt&start=117&cid=514>

In Europe, two thinning chemicals, ethephon and ammonium thiosulphate (ATS), have been evaluated extensively. Ethephon is registered in some European countries (e.g. Germany) for use on culinary plums. Considerable experience has been gained using ethephon (including Flordimex) as a thinning agent not only for thinning flowers but also when sprayed to fruitlets 35-40 days after full bloom. In Germany, 250ml of Flordimex 420 (420g/l ethephon) are used in this way.

Ethephon also promotes the formation of flower bud for the following year and, even if there is no effect on fruit thinning in the year of application, there will be an increase in the number of flowers the next year. In some years it reduces the number of plums

but it does not lead to an increase in size of the remaining fruit. It has been reported that there are some problems using ethephon because its effectiveness is known to be extremely dependent on weather conditions both at the time of application and also the following period. Thinning is more effective during warm humid conditions compared with cold weather. There are also examples of excessively strong thinning effects and the stimulation of gummosis.

In thinning trials conducted by Dr Blanke in Bonn, plums thinned with an ethylene releasing compound were softer and ripened earlier than the control treatment.

In the UK the only form of an ethylene releasing compound with approval for use on top fruit is Cerone, which is approved for use on cider trees. A number of ethephon products only have UK approval for use on cereals.

ATS is now routinely used in the UK and has been widely trialled on plums in Europe. Good results have been achieved by applying ATS when the older bearing wood is in full bloom, followed by a second spray when the one year old wood is flowering. The second spray does not always result in extra thinning.

It has also been found that the risk of excessive thinning from two applications is relatively small. The recommended dose is 18 to 22 litres ATS (58% active ingredient) per hectare.

Swiss researcher Albert Widmer preferred two lower dose applications rather than one higher dose. He also found that spraying in dry weather was more effective for plums whereas on apples a high relative humidity worked best.

Trials in Southern Germany found that thinning sprays at full bloom forwarded harvest by 3 or 4 days, resulting in higher crop value. In trials on culinary plums ATS applied 4-6 weeks after flowering successfully thinned fruitlets to an average size of 35.5mm compared to the 33.6mm of the untreated control. In the same trial, a single spray of ATS at blossom followed by manual thinning resulted in an average fruit size of 38.9mm.

In 2011, trials in Switzerland at the Forschungsanstalt Agroscope Changins-Wadenswil, showed that chemicals used to thin flowers and fruits on apple, were insufficiently effective on plums.

Further reading:

<http://trove.nla.gov.au/work/157930677?versionId=172156619>

Also European Fruitgrowers Magazine edition 2012-03

3. Conclusions

Successful mechanical thinning has been demonstrated in North America and Europe and offers considerable savings in labour compared with hand thinning. Chemical thinners have been trialled but their effectiveness has proved to be unreliable. Tractor mounted and hand held thinning equipment that thin plums effectively are commercially available in the UK. Compared with chemical thinning mechanical thinning does not need regulatory approval and could be implemented for commercial use in the UK immediately.

Plums grown on a fruit wall system would be more suitable for the tractor mounted mechanical thinning equipment but the hand held 'Electro'flor' could be used on modified individual trees. In a commercial situation a combination of mechanical blossom thinning followed by hand thinning may be the most successful combination.

4. Potential for further study on stone fruit thinning

Trials are required in the UK to demonstrate the effectiveness and relative costs of both tractor mounted and hand held thinning machines. This study suggests that plums grown on a fruit wall system would be suited to mechanical thinning. Darwin machines are already working in the UK and could easily be used in trials. The Bonner also appears to have potential on a slightly wider range of tree types. The hand held 'Electro'flor' is a versatile thinning tool that offers the potential of a targeted approach to thinning and should be evaluated.

The trials would demonstrate the effectiveness of mechanical thinning machines on UK varieties under our climatic conditions.