Hort Innovation

Final Report

Productivity, Irrigation, Pests and Soils (PIPS) Orchard Productivity Program (Project extension)

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Project code:

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Content

Summary

The work reported here is an extension of the PIPS Orchard Productivity Program. As the interim final report submitted in March 2015 covered the work undertaken, outputs and outcomes up to December 2014, the contents of this report are restricted to the work undertaken as part of the variation to use unspent funds to take the original study one step further by examining artificial spur extinction (ASE) in conjunction with chemical thinning in a two-year study on the cultivars 'Gala' and 'Fuji'.

The original study examined only ASE, with no comparison of ASE with current best practice chemical thinning programs. Growers were concerned about the economics of ASE management, and were not convinced that chemical thinning would no longer be needed. Hence the aim of this extension to the original project was to demonstrate the benefits of ASE over chemical thinning and provide information on the cost of implementing ASE.

Two small plot trials were established on 'Gala' and 'Fuji' comparing ASE and chemical thinning for crop load management, and a large semi-commercial scale demonstration site was set up to (i) confirm results of the small-plot trials on a larger scale, and (ii) enable accurate measurement of labour requirements for a cost comparison between ASE and chemical thinning. Economically, ASE

This study has demonstrated clearly that ASE is a feasible tool for managing crop load without the need for chemical thinning. It produces higher yields and improved fruit quality, while giving the grower the ability to determine the desired fruit number and placing on the tree. Unlike chemical thinning, it provides a tool for precision crop load management, enabling optimisation of bud position and improved light distribution within the canopy. On top of these significant benefits, it simplifies the hand-thinning task, fruit maturity is more even, it is not weather dependent and it removes the negative impact that most chemical thinners have on fruit size and shape.

The cost comparison between ASE and chemical thinning for crop load management has confirmed that implementation of ASE is economically viable for orchardists. The cost in the year of implementation is comparable to conventional crop load management methods, and in subsequent years ASE management is more economical than conventional chemical thinning.

Use of ASE for crop load management is a new paradigm requiring a different mindset, but if growers are able to put aside their fear of moving from the known (chemical thinning) to the unknown (ASE) they will have more control over their yields and fruit size. The benefits to industry include:

- Improved orchard productivity through minimised resource use and increased efficiency
- Increased grower confidence in benefits of precision-based tree management systems
- Increased grower ability to achieve productivity increases through improved management of tree structure
- Reduced risk in crop load management

To assist growers in implementing ASE and move away from chemical thinning, it is strongly recommended that demonstration sites be established in the major growing regions. These sites will provide the opportunity to train growers in the correct use of ASE and give them an opportunity to see the benefits first hand.

Keywords

Apple; crop load management; chemical thinning; artificial spur extinction; fruit quality; yield

Introduction

The work reported here is an extension of the PIPS Orchard Productivity Program. As the interim final report submitted in March 2015 covered the work undertaken, outputs and outcomes up to December 2014, the contents of this report are restricted to the work undertaken as part of the variation to use unspent funds to take the original study one step further by examining artificial spur extinction (ASE) in conjunction with chemical thinning in a two-year study on the cultivars 'Gala' and 'Fuji'.

What is Artificial Spur Extinction?

High natural spur extinction corresponds closely to cultivars that are least susceptible to alternate bearing. Artificial Spur Extinction (ASE) is a crop load management tool imitating natural bud extinction by reducing bud density through manual removal of buds. It precisely defines where and how much fruit is set on each limb of the tree. The aim of ASE is to promote the vigour and performance of floral spurs, stimulate spur strength and improve fruit quality and regularity of production.

Because the bulk of the thinning is completed prior to flowering, there is minimal resource wastage in ASE managed trees, hence fruit size is greater than in conventionally managed trees. There is also a positive response in fruit set of individual buds with the proportion of buds failing to set fruit being reduced and an increased proportion of buds setting multiple fruit. Return bloom is accentuated, reducing the risk of biennial bearing. Yields of 100 t/ha of high quality fruit are achievable.

Need for this study:

The original study examined only ASE, with no comparison of ASE with best practice chemical thinning programs. Growers were concerned about the economics of ASE management, and were not convinced that chemical thinning would no longer be needed.

Hence the key research questions arising from the original study were:

1. Is ASE effective on cultivars with an extreme biennial bearing tendency, such as 'Fuji'?
2. Do ASE managed trees respond to chemical thinners?
3. Can ASE technology be successfully merged with chemical thinning to optimise yields and fruit quality?
4. How does ASE technology compare directly with best practice chemical thinning programs in terms of yield, fruit quality, and cost?

Methodology

1. Small plot replicated field trials

Trials were established on a commercial orchard in the Huon Valley, Tasmania on two cultivars: 'Alvina Gala' and 'Fiero Fuji'. The following treatments were established in each cultivar:

1. Conventional management
2. ASE management
3. Conventional + chemical thinning
4. ASE + chemical thinning

Each treatment was replicated six times, and three limbs were tagged in each tree for assessment of flower number and fruit set.

All trees were pruned in late winter; unbalanced limbs were removed and then remaining limbs spaced out to six limbs per metre of tree height. On the ASE trees, floral buds were thinned as follows:

- Gala set at 5 buds/cm^2 LCSA in 2015/16 and 6 buds in 2016/17
- Fuji set at 6 buds/cm^2 LCSA in both years

In the first year of the study, several of the 'Fuji' trees were experiencing an off-year with low floral bud numbers. The number of flower clusters were recorded for each tree.

Chemical thinning

A full chemical thinning program, using the bloom thinners Ethrel® (ethephon) and NAA, and post-bloom thinner Maxcel® (BA), was undertaken on trees tagged for chemical thinning. All sprays were applied using a backpack sprayer. Ethrel and NAA were applied to runoff and MaxCel applied to point of drip. The wetter Kendeen was included at the label rate for all applications. Application details are outlined in Table 1.

Table 1: chemical thinning program applied to 'Gala' and 'Fuji' trial trees in each season.

	Chemical	Rate	Application time	Date applied Season 1	Date applied Season 2
Alvina Gala	Ethrel 720	400 ml/ha	Full bloom	7 Oct 2015	13 Oct 2016
	NAA (4%)	10 ppm	7 dAFB	14 Oct 2015	19 Oct 2016
	MaxCel (BA)	9 L/ha	16 dAFB	27 Oct 2015	29 Oct 2016
Fiero Fuji	Ethrel 720	400 ml/ha	Full bloom	7 Oct 2015	13 Oct 2016
	MaxCel (BA)	9 L/ha	16 dAFB	27 Oct 2015	29 Oct 2016

The flowering period in the first season was extremely short, with flowering commencing on 2nd October and 100% bloom reached by 8th October; full bloom occurred on 6th October.

Fruit set and hand-thinning

Fruit set was measured on all treatment trees prior to hand-thinning by recording the number of fruit within

each cluster. ASE trees were hand-thinned to the required numbers in early-mid November of each season. On the conventional treatment trees, hand-thinning was undertaken in early December following natural fruit drop, approximately six weeks after full bloom (AFB). Fruit was harvested at normal commercial harvest.

Fruit quality assessments

At harvest the number of fruit per tree was counted and a random sample of 50 fruit picked from the northern side of each tree. Fruit was returned to the laboratory where it was weighed and a subsample of 30 fruit taken for fruit quality assessments. The fruit quality assessments undertaken were: weight, diameter, length, background colour, red blush coverage, flesh firmness, total soluble solids content and malic acid content.

Data analysis

All data was analysed by analysis of variance using Genstat release 17.1 (VSN International Ltd).

Determining costs for comparison of ASE and chemical thinning

The time taken for pruning, tree setup and hand-thinning were measured for each treatment. However as the trials involved a small number of trees the decision was made to set up a larger block in spring 2016 and use this for the assessment of labour costs to provide more accurate figures.

2. Demonstration site

A demonstration site was established in a block of 'Buckeye Gala' on M26 rootstock in September 2016 at Rookwood Orchard, Ranelagh. The demonstration block consisted of five regimes:

1. ASE
2. ASE + chemical thinning (CT)
3. Grower prune + ASE
4. Grower prune + ASE + CT
5. Standard crop load management (grower prune + CT)

Because most growers tend to leave more limbs in the tree than is recommended for ASE, we included a 'grower prune' regime to allow us to compare the difference between our 'standard ASE' and the level of pruning that would be undertaken by most growers. The setup pruning in regimes 1 and 2 reduced the number of limbs down to a maximum of 6-7 limbs per metre of tree height, tied down upright limbs to a more horizontal position and removed spurs and small twiggy branches from the main trunk, compared with the grower prune which had 9-10 limbs per metre of tree height and the main trunk was left untouched. This meant that regimes 1 and 2 had less wood, allowing more light into the tree.

A full row was dedicated to each regime. Rows consisted of 67 trees. Every 10th tree in each row was tagged and used for assessments. The same assessments were undertaken as described for the small plot trials.

The chemical thinning program consisted of bloom applications of Ethrel® (ethephon) and NAA and a post-bloom tank mix application of Maxcel® and carbaryl. All chemical thinning applications were applied by the grower using his normal tractor and sprayer.

Determining costs for comparison of ASE and chemical thinning

As noted above, the decision was made to use the larger demonstration site for cost comparisons between ASE and chemical thinning.

To compare the costs of the different regimes, the time taken to prune, complete the ASE setup (bud removal) and hand-thin were recorded and used to calculate the cost per hectare of each activity based on a labour cost of $25 per hour.

The chemical thinning cost included the cost of chemicals, labour at $25 per hour and a machinery cost of $25 per hour for the tractor/sprayer.

3. Technology transfer

A range of methodology was used for technology transfer of the project results, including:

(i) Formal presentations at industry meetings
(ii) Participation in field days
(iii) Demonstration day
(iv) Articles published in industry magazines
(v) Media interview and video production

Outputs

Presentations to industry:

- Preliminary results presented at FGT Pome fruit winter field day following the Huon Future Orchards Walk on 16th June 2016
- Presentation at APAL Industry Update on 23rd June 2016
  "Do chemical thinners give better results than Artificial Spur Extinction? "
- Presentation at APAL Speed Updating at FGT conference on 25th May 2017
  "Is precision crop load management without chemicals feasible? "

Field days:

- The trial site was part of a field walk conducted as part of the Fruit Growers Tasmania "Tasmanian Fruits Extension Day" on 20th November 2015. At the site, the principles of ASE were explained and participants had the opportunity to compare differences between ASE and conventional management
- ASE demonstration and hands-on field day at Calvert Bros. Rookwood Orchard, Ranelagh, Tas. Conducted on Thursday 8th September 2016
- Demonstration and discussion on ASE held as part of the Spreyton, Tas Future Orchards Walk on Monday 12th September 2016
- Assisted Ross Wilson, PIPS extension for Future Orchards, to set up ASE trees and discuss with participants at the Tasmanian Future Orchards walk on 19th June 2017

Industry articles:

- Article published in industry magazine: 'Are chemical thinners necessary?'
  Australian FruitGrower, Vol 10 (5), pp 22-25, Oct/Nov 2016
- Article published in industry magazine: "Precision crop load management without chemicals"
  Australian Fruitgrower, Vol 11 (4), pp 33-35, Aug/Sept 2017
- Article submitted for publication in industry magazine: "New tool for precision crop load management"
  Australian Fruitgrower, Feb/Mar 2018

Media interviews and videos:

- ASE demonstration video recorded with Richelle Zealley (APAL) on 12th September 2016.
  posted on youtube: https://www.youtube.com/watch?v=SwOSnqoS5t4
  over 1,000 views as of 20th December 2017
- ABC Country hour interview 12th September 2016, aired on Wednesday 14th September

Other publications:

- Fact sheet available on the TIA website: Chemical free crop load management
  http://www.utas.edu.au/__data/assets/pdf_file/0006/978099/Chemical-free-crop-load-apples.pdf
- Orchard plant protection guide for deciduous fruits in NSW 2017-18
  ASE included in feature article: “Crop load management in deciduous tree crops”

Outcomes

This project has successfully achieved the aim of demonstrating the benefits and economic viability of ASE, showing that it is a superior tool for crop load management compared with the conventional method of use of chemical thinning agents. The study has provided answers to the key research questions that arose from the original PIPS Tree Structure project.

1. Is ASE effective on cultivars with an extreme biennial bearing tendency, such as 'Fuji'?

'Fuji' responded well to ASE in both years of the study, achieving improved yield and fruit quality over the conventional management method.

2. Do ASE managed trees respond to chemical thinners?

The response of ASE managed trees to chemical thinners was variable, but this was no different to the response of conventionally managed trees to chemical thinning. In the instances that ASE trees did respond to chemical thinning, the result was reduced yields.

3. Can ASE technology be successfully merged with chemical thinning to optimise yields and fruit quality?

While ASE technology can be merged with chemical thinning, there is no benefit as yields are reduced below optimum and fruit quality is not as high as when using ASE alone for crop load management.

4. How does ASE technology compare directly with best practice chemical thinning programs in terms of yield, fruit quality, and cost?

ASE technology produces superior results in terms of both yields and fruit quality. The cost of implementation in the first year is equivalent to a full chemical thinning program, but the cost in subsequent years is less than chemical thinning, so in the long term it is actually cheaper than a conventional chemical thinning program.

As well as providing an economic benefit to growers, implementation of ASE for managing crop load also provides social and environmental benefits. By eliminating the need for chemical thinning, growers have more time and less stress in the busy spring period when chemical thinning would normally be undertaken. There is also a reduction in chemical use on the orchard and an associated reduction in water use with the removal of spray applications.

Evaluation and discussion

As well as confirming previous results with artificial spur extinction, this project has provided valuable information on the interaction between ASE and chemical thinning.

Flowering and fruit set

In ASE managed trees the number of floral buds (clusters) is reduced prior to bud burst, resulting in fewer buds than in conventionally managed trees, but the proportion of flower clusters setting fruit is higher than in conventional management, with a greater number of multiple fruit per cluster. Under conventional tree management it is not uncommon to see 30-50% of spur and terminal buds failing to set fruit, while under ASE management the number of buds failing to set is reduced to less than 5%.

The number of clusters in the ASE trees was stable across the two years of this study, with most floral buds setting fruit. This was in agreement with the results of the four year study in the initial phase of the PIPS program, and is most likely due to stronger buds and less competition for resources. ASE managed trees showed no signs of biennial bearing, unlike the conventional trees in which bud numbers varied between seasons.

As expected, ASE managed trees had adequate return boom to set a crop load of 6 fruit/cm^2 limb cross-sectional area based on a single fruit per bud, with minimal wastage of resources into non-setting flowers and/or fruit that would be later removed.

Yield and fruit quality

Yields were higher under ASE management, achieving over 60 t/ha in the Gala. Yield in Fuji, notorious for its biennial bearing habit, were 30% higher in year 1 and doubled in year 2 compared with conventional management.

Fruit size under ASE management was improved compared with conventional and in ‘Gala’ fruit shape was improved under ASE management.

The response of ASE managed trees to chemical thinning varied between years, but the yields and fruit size obtained with ASE (no chemical thinning) demonstrate that ASE is a stand-alone method for crop load management.

The semi-commercial scale demonstration trial confirmed the findings of the smaller trials.

Cost comparison

Results have demonstrated that ASE has the potential to supersede chemical thinning, with ASE managed trees producing better crop loads and fruit quality compared to the conventionally managed trees. The cost comparison between ASE and chemical thinning for crop load management (see Appendix 1) has confirmed that implementation of ASE is economically viable for orchardists. The cost in the year of implementation is comparable to conventional crop load management methods, and in subsequent years ASE management is more economical than conventional chemical thinning.

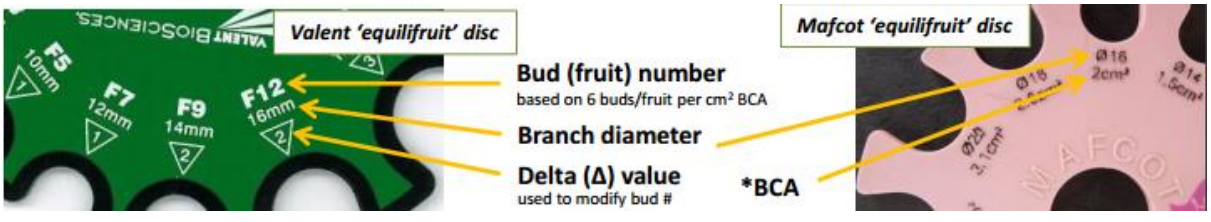
Although the first year of ASE implementation is labour intensive, this is compensated by the reduction in

hand-thinning. A major advantage of ASE is that spacing, position and number of clusters are already set up by the bud thinning process, so all that is required when hand-thinning is to break up bunches and remove fruit with defects. Thus the hand-thinning process is considerably simplified when compared with conventional management.

Technology transfer

The range of methodologies used for technology transfer have resulted in good awareness of the project and of ASE technology. Articles in industry magazines have been well read, and the video produced by APAL has received in excess of 1,000 views.

There have been multiple requests from growers for the equilifruit discs. These were originally obtained through Valent BioSciences, however are no longer available. To enable the continued uptake of ASE technology, it is strongly recommended that APAL ensure that discs be produced in Australia and made available to growers.



This study has demonstrated clearly that ASE is a feasible tool for managing crop load without the need for chemical thinning. It produces higher yields and improved fruit quality, while giving the grower the ability to determine the desired fruit number and placing on the tree. Unlike chemical thinning, it provides a tool for precision crop load management, enabling optimisation of bud position and improved light distribution within the canopy. On top of these significant benefits, it simplifies the hand-thinning task, fruit maturity is more even, it is not weather dependent and it removes the negative impact that most chemical thinners have on fruit size and shape

Most growers think that chemical thinning is doing a good job and are reluctant to change a system that they perceive is doing a great job for them. However the reality is that chemical thinning is unreliable and fruit quality is below optimum. Chemical thinning has certainly served the industry well over the last few decades, but modern techniques such as ASE enable precision management of crop load, something that has been missing with chemical thinning.

Use of ASE for crop load management is a new paradigm requiring a different mindset, but if growers are able to put aside their fear of moving from the known (chemical thinning) to the unknown (ASE) they will have more control over their yields and fruit size. The following is a summary of the benefits to industry:

- Improved orchard productivity through minimised resource use and increased efficiency

- Increased grower confidence in benefits of precision-based tree management systems
- Increased grower ability to achieve productivity increases through improved management of tree structure
- Reduced risk in crop load management

Recommendations

Moving away from chemical thinning for crop load management requires a change in mind set, but with its simplified hand-thinning and high fruit quality, ASE can reduce both time and cost to the grower.

To assist growers in implementing ASE and move away from chemical thinning, it is strongly recommended that demonstration sites be established in the major growing regions. These sites will provide the opportunity to train growers in the correct use of ASE and give them an opportunity to see the benefits first hand.

Scientific refereed publications

Chapter in a book

Case study published as part of: Close, DC and Bound, SA, “Advances in understanding apple tree growth: the manipulation of tree growth and development”, In *Achieving Sustainable Cultivation of Apples*, Burleigh Dodds Science Publishing, K Evans (ed), United States, pp. 53-84. ISBN 978-1-78676-032-6 (2017)

Intellectual property/commercialisation

No commercial IP generated

Acknowledgements

Thanks to Scott Price, manager of Calvert Brothers Rookwood orchard at Ranelagh (now R&R Smith), for use of his orchard and provision of trees.

Appendices

1. Cost comparison – ASE vs chemical thinning

2. Industry presentations
   i. Preliminary results presented at FGT Pome fruit winter field day following the Huon Future Orchards Walk on 16th June 2016
   ii. Presentation at APAL Industry Update on 23rd June 2016
   "Do chemical thinners give better results than Artificial Spur Extinction? "
   iii. Presentation at APAL Speed Updating at FGT conference on 25th May 2017
   "Is precision crop load management without chemicals feasible? "

3. Field days
   ASE demonstration and hands-on field day at Calvert Bros. Rookwood Orchard, Ranelagh, Tas. Conducted on Thursday 8th September.

4. Media interviews and videos
   ASE demonstration video produced by APAL
   https://www.youtube.com/watch?v=SwOSnqoS5t4

5. Industry articles
   i. Bound, S (2016) 'Are chemical thinners necessary?' Australian FruitGrower, 10(5): 22-25.
   ii. Article submitted to Australian Fruit Grower, May 2017
   "Precision crop load management without chemicals"

6. Other publications
   Fact sheet available on the TIA website:
   http://www.utas.edu.au/__data/assets/pdf_file/0006/978099/Chemical-free-crop-load-apples.pdf

Appendix 1 – ASE vs chemical thinning

The cost comparison was undertaken on the demonstration site, with 67 trees in each regime. Note that pruning costs are included, as pruning is the first step in crop load management.

The time taken to prune, complete the ASE setup (bud removal) and hand-thin were recorded for each regime and used to calculate the cost per hectare of each activity based on a labour cost of $25 per hour.

The chemical thinning cost included: cost of chemicals based on a per hectare rate, labour at $25 per hour and a machinery cost of $25 per hour for the tractor/sprayer.

The first year of ASE implementation is the most labour intensive as it involves some restructuring of trees, and removing buds across the entire tree. In subsequent years, pruning is reduced to the level that would normally be undertaken in the orchard and it is only necessary to remove buds on new wood, thus further reducing costs.

	Costs ($/ha)				
	Pruning	ASE setup	Hand-thinning	Chemical thinning	**Total**
(i) Year 1 *(initial ASE implementation)*					
SP + ASE	2,604	2,604	5,208	-	**10,417**
SP + ASE + CT	2,604	2,604	4,688	623	**10,519**
GP + ASE	1,823	2,865	6,354	-	**11,042**
GP + ASE + CT	1,823	2,865	6,250	623	**11,561**
GP + CT (standard)	1,823	-	7,813	623	**10,258**
(ii) Year 2					
ASE	1,823	1,302	5,208	-	**8,333**
Standard (GP + CT)	1,823	-	7,813	623	**10,258**

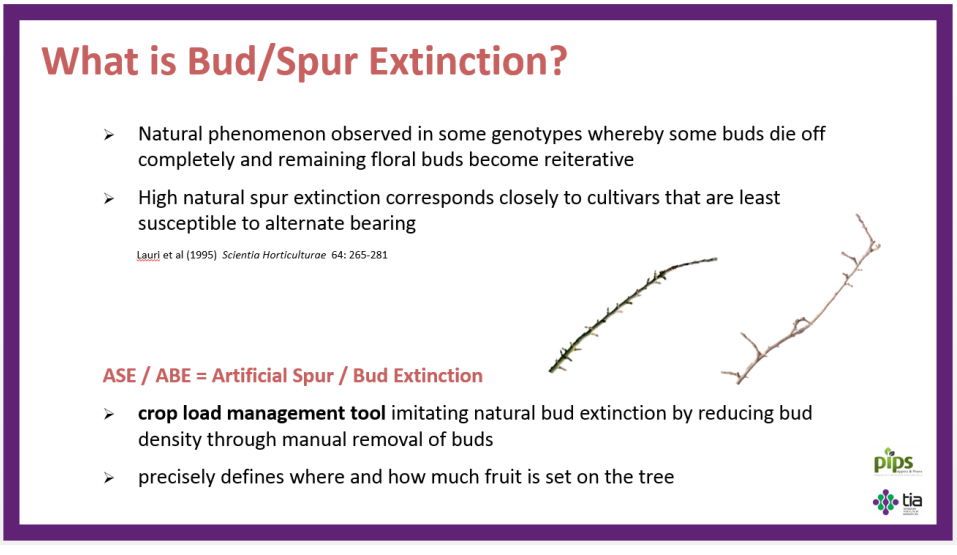
SP = setup prune, ASE = Artificial Spur Extinction, GP = grower prune, CT = chemical thinning

The costing above demonstrate that the cost of implementing ASE in an established orchard is similar to the cost of a standard chemical thinning program, and once the trees are set up, the cost of crop load management drops.

It should be noted that the cost of implementation will vary depending on the age and structure of the trees. However, there is the added benefit that trees can be set up with a pre-determined crop load with reasonable accuracy, thus enabling improved management of fruit size. In addition, bud position is optimised in ASE, fruit is well spaced and light distribution into the canopy is enhanced.

Appendix 2 – Industry presentations

(i) Preliminary results presented at FGT Pome fruit winter field day following the Huon Future Orchards Walk on 16th June 2016

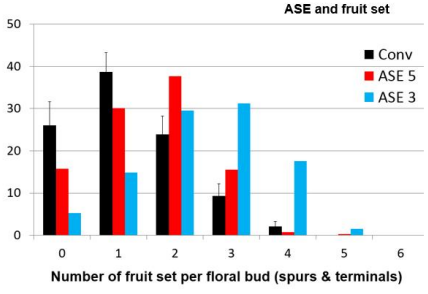


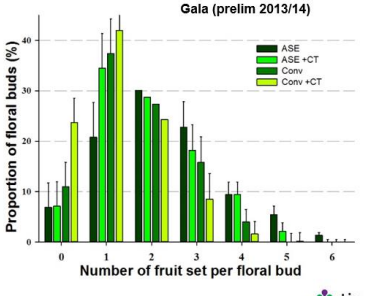
Benefits of ASE

- achieve accurate, predictable crop loads
- promote vigour / performance of floral spurs
- stimulate spur strength
- improve fruit quality
- ensure regularity of production
- remove need for chemical thinners?
  - preliminary 1-year study (Gala) suggested yes
  - 2-year study (Gala & Fuji) commenced 2015

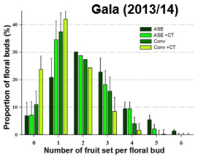
Fruit set response

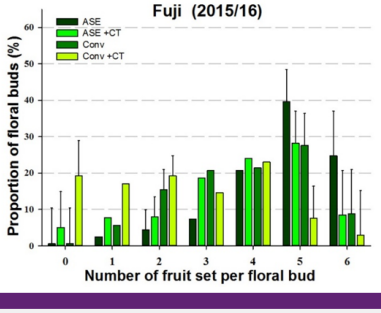
- ASE greater proportion of buds setting multiple fruit

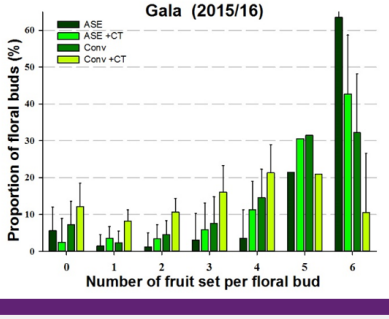




- ASE > proportion of buds with multiple fruit, even in season with very high set
- Cultivar and seasonal differences

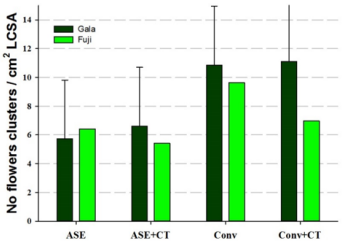




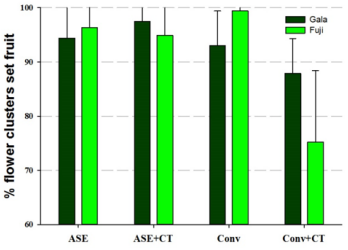


ASE and chemical thinning (year 1: 2015/16)

Flower clusters

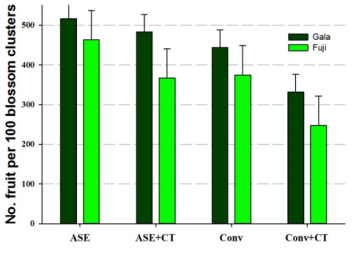


% clusters set

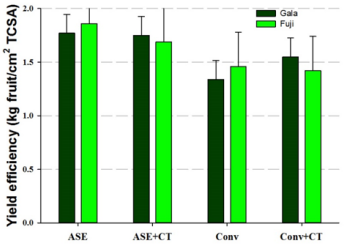


- Flower buds reduced prior to bud burst (Fuji were off-year)
- High proportion of buds set fruit in 2015 (unusual season)
- Note that 1st year of setup can get variable results, settles down in 2nd year

Fruit set %

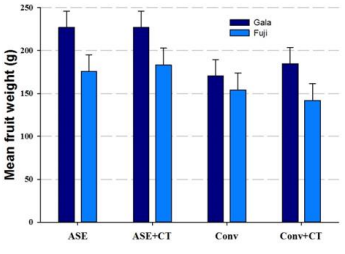


Yield efficiency

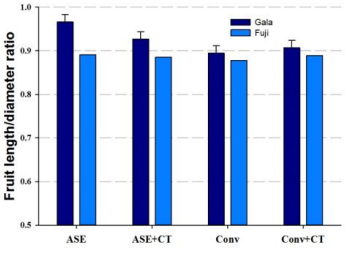


- ASE higher percentage fruit set than conventional
- Chemical thinning impact reduced in ASE trees cf conventional
- Improved yield efficiency with ASE, chemical thinning no effect

Fruit weight



Fruit shape



- Larger fruit from ASE trees
- Gala improved fruit shape with ASE

Conclusions

- ASE allows reduction in floral bud density without loss of commercial harvest potential
  - reduces the proportion of floral buds failing to set
  - increases the proportion of floral buds setting multiple fruit
- Simplifies hand thinning, as spacing, position and # clusters are already set
  - hand thinners able to focus solely on breaking up fruit bunches and removing fruit with defects
- Improved fruit weight / shape with ASE
- Data suggesting that no advantage in application of chemical thinners to ASE managed trees
- Continue study to confirm
- Establish ASE demonstration site

Thanks to…

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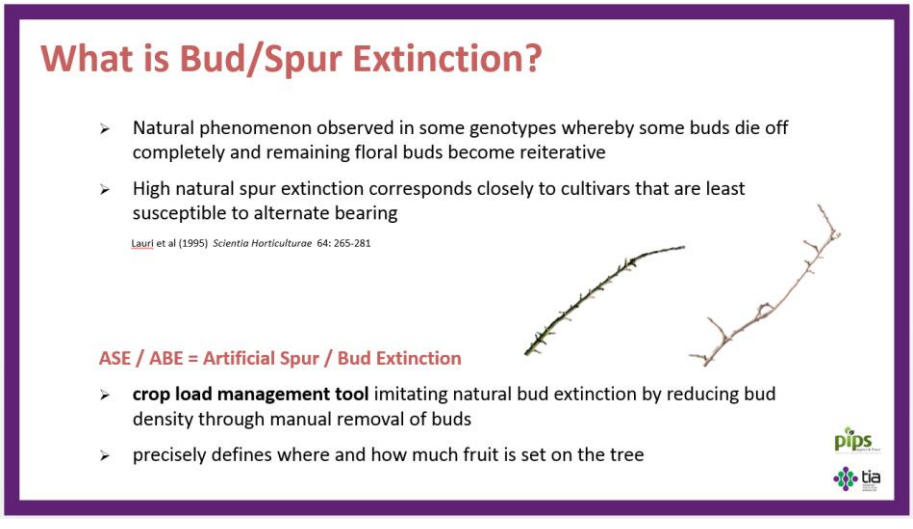
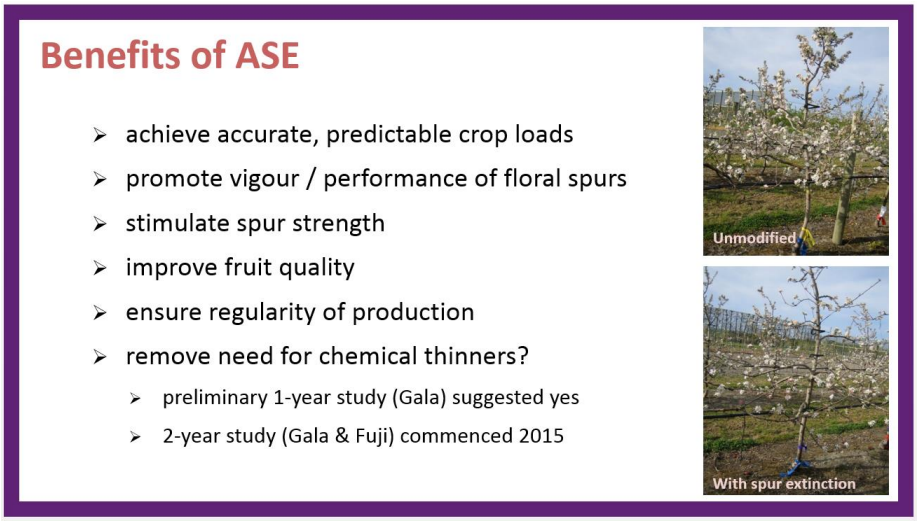
HIA and the apple industry for provision of funding

… and to all the growers who have given us access to their trees

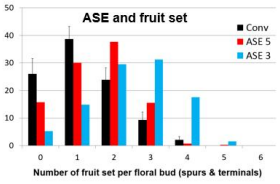
(ii) APAL industry update, delivered 23rd June 2016

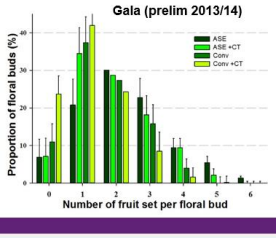


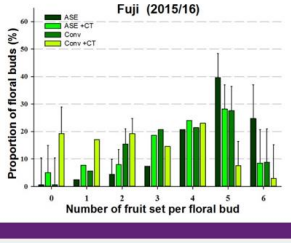


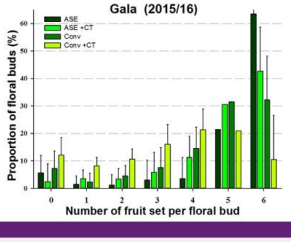
Fruit set response

- ASE greater proportion of buds setting multiple fruit, even in season with very high set
- Cultivar and seasonal differences





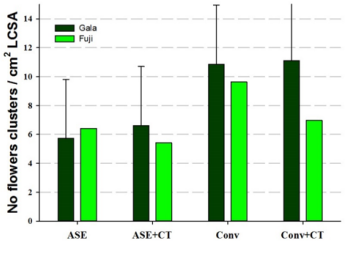




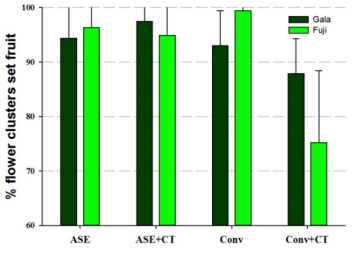
ASE and chemical thinning (year 1: 2015/16)

- Flower buds reduced prior to bud burst (Fuji were off-year)
- High proportion of buds set fruit in 2015 (unusual season)
- Note that 1st year of setup can get variable results, settles down in 2nd year

Flower clusters



% clusters set



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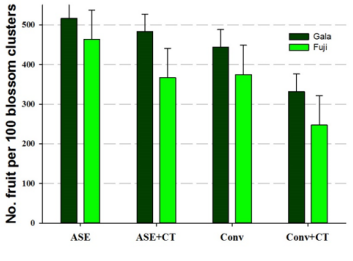
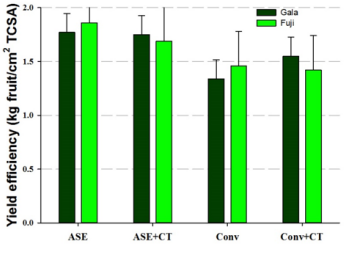
- Improved yield efficiency with ASE, chemical thinning no effect

Fruit set %



Yield efficiency



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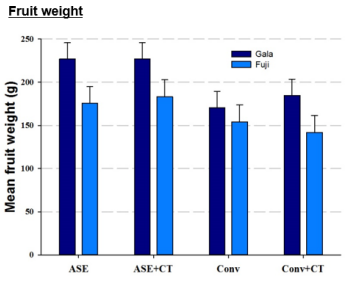

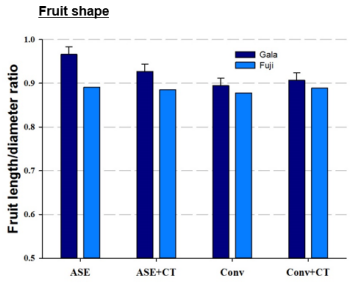

Conclusions

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- Simplifies hand thinning, as spacing, position and # clusters are already set
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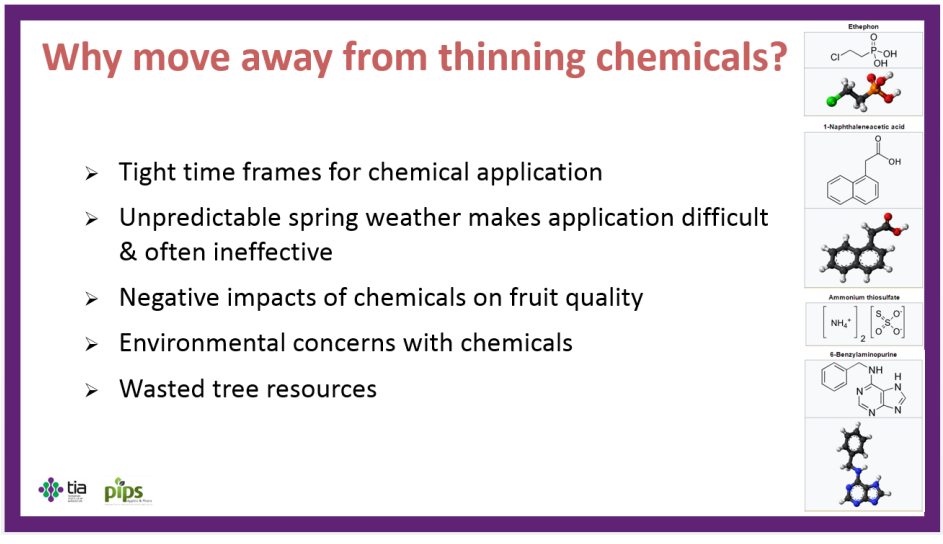
HIA and the apple industry for provision of funding

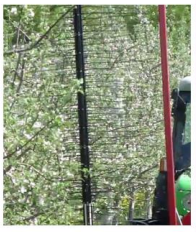
… and to all the growers who have given us access to their trees

(iii) Presentation at APAL Speed Updating at FGT Conference on 25th May 2017



Options?

- Pruning
- Mechanical thinning
- Flower removal
- Hand thinning
- Bud thinning / removal



What is Bud/Spur Extinction?

- Natural phenomenon observed in some genotypes whereby some buds die off completely and remaining floral buds become reiterative
- High natural spur extinction corresponds closely to cultivars that are least susceptible to alternate bearing

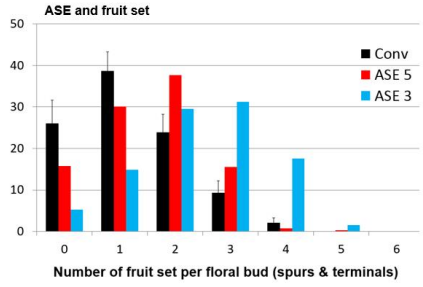
Lauri et al (1995) *Scientia Horticulturae* 64: 265-281

ASE = Artificial Spur Extinction

- **crop load management tool** imitating natural bud extinction by reducing bud density through manual removal of buds
- precisely defines where and how much fruit is set on the tree

Summary of PIPS 1 studies

- ASE greater proportion of buds setting multiple fruit
- fruit quality: terminal > spur > axillary



Questions arising from PIPS 1 studies

- How do ASE managed trees respond to chemical thinners?
- Is ASE effective on cultivars with an extreme biennial bearing tendency, such as *Fuji*?
- Can ASE technology be successfully merged with chemical thinning to optimise yields and fruit quality?
- How does ASE technology compare with best practice chemical thinning programs in terms of yield, pack-outs, and cost:benefit?

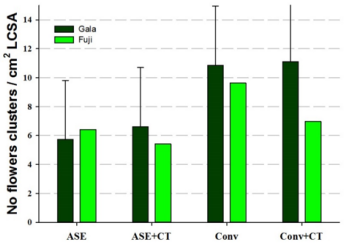
What we did

- 2 year study to examine ASE & chemical thinning on the cultivars 'Gala' and 'Fuji'
  - ASE
  - ASE + chemical thinning (CT)
  - Conventional
  - Conventional + CT
- Demonstration site using whole rows (2016/17)
  - ASE
  - ASE + CT
  - Grower prune + ASE
  - Grower prune + ASE + CT
  - Standard CL management (grower prune + CT)

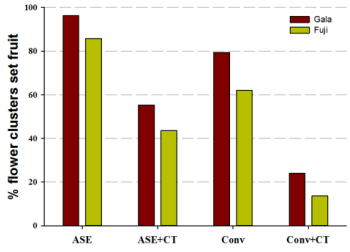
Flowering & fruit set

- Flower buds reduced prior to bud burst (Fuji were off-year in 2015/16)
- Note that 1st year of setup can get variable results, settles down in 2nd year

Flower clusters



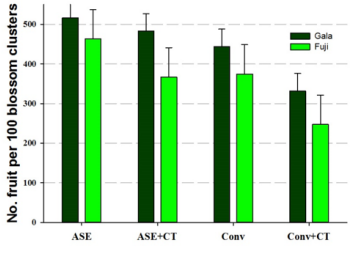
% clusters set



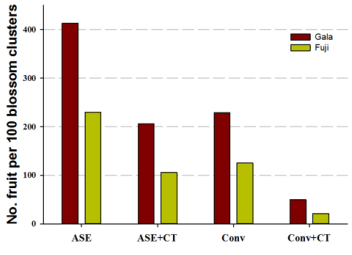
Fruit set response

- ASE higher percentage fruit set than conventional
- High proportion of buds set fruit in 2015 (unusual season)
- Chemical thinning impact reduced in ASE trees cf conventional in 2015

2015/16



2016/17



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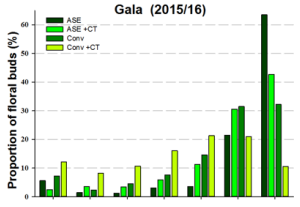
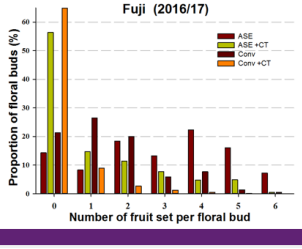
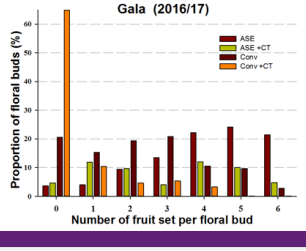


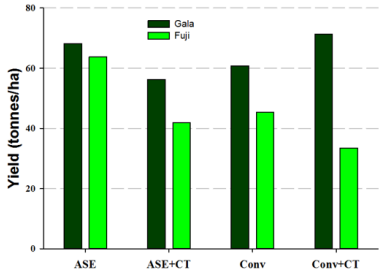




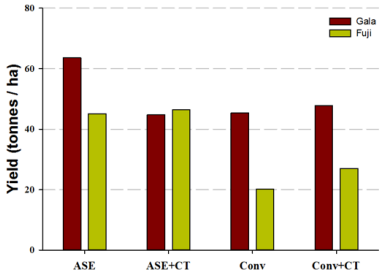
Yield (tonnes/ha)

- ASE = more consistent yields across seasons

2015/16



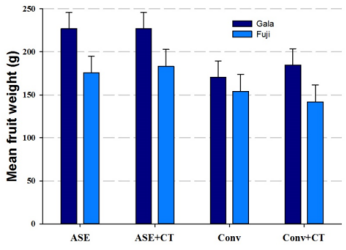
2016/17



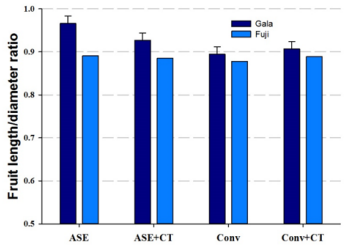
Fruit quality

- Larger fruit from ASE trees
- Gala - improved fruit shape with ASE

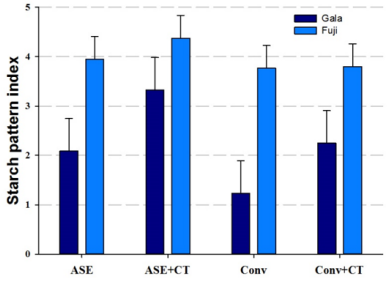
Fruit weight



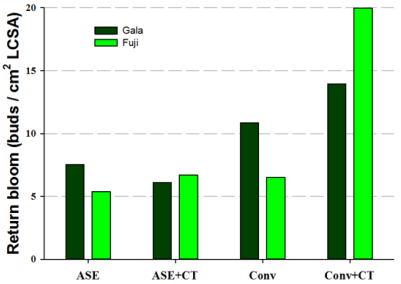
Fruit shape



Fruit maturity (Starch Pattern Index)



Return bloom



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- Simplifies hand thinning, as spacing, position and # clusters are already set
  - hand thinners able to focus solely on breaking up fruit bunches and removing fruit with defects
- Improved fruit weight / shape with ASE
- Data suggesting that chemical thinners not necessary in ASE managed trees
- Cost:benefit analysis – watch this space

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Simon Middleton, John Wilkie & Heidi Parkes (DEEDI, Queensland)

HIA and the apple industry for provision of funding

Scott Price from Calvert Bros Rookwood Orchard for giving us free reign in the orchard

Appendix 3 – Field days

ASE demonstration session at Rookwood orchard, Ranelagh on 8th September 2016

Apple ASE demo

When: Thursday 8th September

Time: 11:00 am - 1pm, *with BBQ lunch*

Where: Rookwood , Rookwood Rd Ranelagh

A hands on session on how to set up trees with artificial spur extinction

- Principles of artificial spur extinction method explained
- Demonstration of artificial bud extinction method by Dr Sally Bound, TIA Perennial Horticulture Centre
- Set up your own tree ***(BYO secateurs)***
- Followed by a BBQ lunch

RSVP: Monday September 5th | Michele or Sally at TIA

michele.buntain@utas.edu.au | 62 266353 | 0429 957 975

Cost: $15 includes BBQ lunch

Fruit Growers Tasmania Inc

tia TASMANIAN INSTITUTE OF AGRICULTURE

pips Apples & Pears PRODUCTIVITY IRRIGATION PESTS AND SOILS

Appendix 4 – video production

ASE demonstration video produced by APAL

https://www.youtube.com/watch?v=SwOSnqoS5t4

Artificial Spur Extinction demonstration

1,063 views

6 0 SHARE

Apple and Pear Australia Ltd (APAL)
Published on 26 Sep 2016

SUBSCRIBE 277

Dr Sally Bound (Tasmanian Institute of Agriculture) demonstrates Artificial Spur Extinction (ASE) as an orchard thinning technique.

Appendix 5 – Industry articles

(i) Article published in Australian Fruit Grower, Vol 10 Issue 5, pp 22-25, Oct/Nov 2016

Are chemical thinners necessary?

By Dr Sally Bound

Spring is here and thinning is on everyone's mind – but are chemical thinners really necessary or even the best way to manage your crop load?

Crop load management is the single most important practice determining the annual profitability of apple orchards, yet it is the most difficult.

Whilst our knowledge of chemical thinning and tree response has come a long way over the last 25 years, using chemicals to control crop load is a fine balancing act, particularly with the unpredictable spring weather conditions experienced in most Australian apple growing regions. This unpredictability combined with environmental concerns associated with some thinning chemicals means that we need to find alternatives to chemical thinning.

The research group in France led by Pierre-Éric Lauri studied the difference between regular and biennial bearing cultivars in the mid 1990s and observed that regular bearers have high natural spur extinction. Following on from these studies, Dr Stuart Tustin and his group in New Zealand further developed the concept of Artificial Spur Extinction (ASE) to manage crop load.

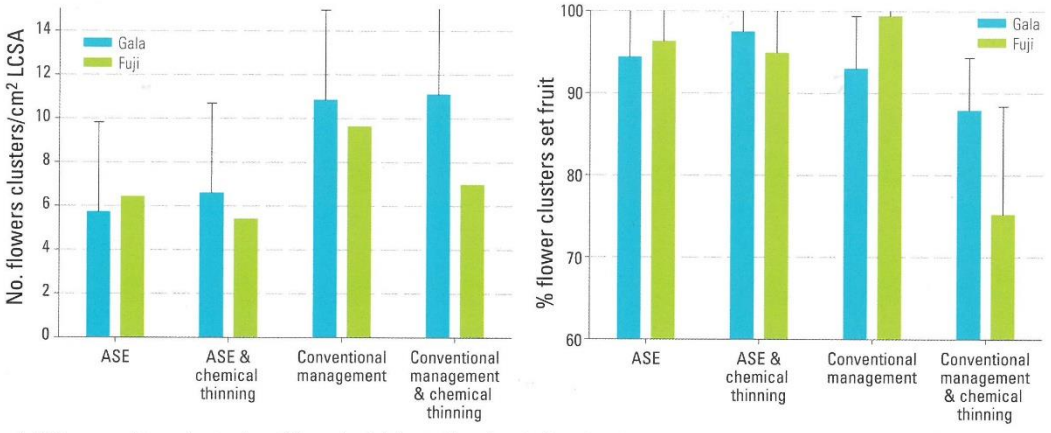
The Productivity, Irrigation, Pests and Soils (PIPS) program has demonstrated the application of ASE under Australian growing conditions, comparing the impact of ASE with conventional pruning management on fruit set response, yield and fruit quality.

Results from this work were extremely positive, however because chemical thinners were not included in this study several questions have arisen:

1. Is ASE effective on cultivars with an extreme biennial bearing tendency, such as Fuji?
2. Do ASE managed trees respond to chemical thinners?
3. Can ASE technology be successfully merged with chemical thinning to optimise yields and fruit quality?
4. Can hand thinning be reduced or eliminated by a combination of ASE and chemical thinning?
5. How does ASE technology compare directly with best practice chemical thinning programs in terms of yield, pack-outs, and the cost to benefit ratio?

Dr Sally Bound demonstrates Artificial Spur Extinction to growers at a Future Orchards walk, Tasmania.

▶ The effects of the different treatments on flowering (left) and fruit set (right) in Gala and Fuji.



In ASE managed trees the number of flower buds (clusters) is reduced prior to bud burst, resulting in fewer buds than in conventionally managed trees.

A preliminary one-year study on Gala in 2013/14 suggested that a chemical thinning program may not be needed in ASE managed trees, but to answer these questions we have established a two-year study on the cultivars Gala and Fuji which commenced in 2015.

In each cultivar, we will compare conventional management with ASE management and we will apply a chemical thinning program to half of the conventionally managed trees and half of the ASE managed trees.

What is ASE?

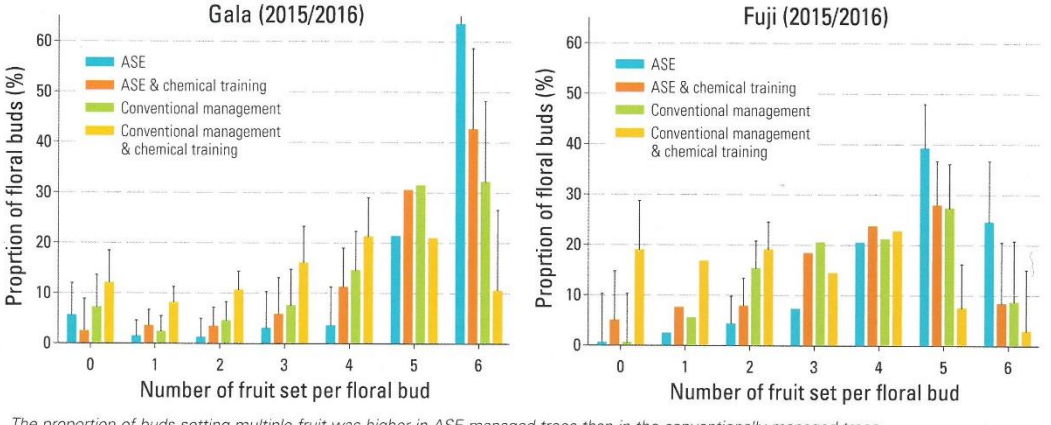
Artificial Spur Extinction (ASE) is a crop load management method using bud thinning techniques to precisely define where and how much fruit is set on each limb of the tree. The aim of ASE is to promote the vigour and performance of floral spurs, stimulate spur strength and improve fruit quality and regularity of production.

The initial setup of trees for ASE involves removal of unbalanced (large) limbs and training of remaining limbs to a near horizontal position, which optimises fruiting whilst restricting excessive vegetative growth.

Floral spurs are then selectively removed while trees are still dormant to precisely define the density and location of potential fruit on the tree. This means that at bud burst ASE managed trees commence spring growth in an already significantly 'crop thinned' state, carrying fewer but stronger flower buds than conventionally managed trees. This reduces competition for tree resources, enabling optimisation of crop load and maximising fruit quality potential.

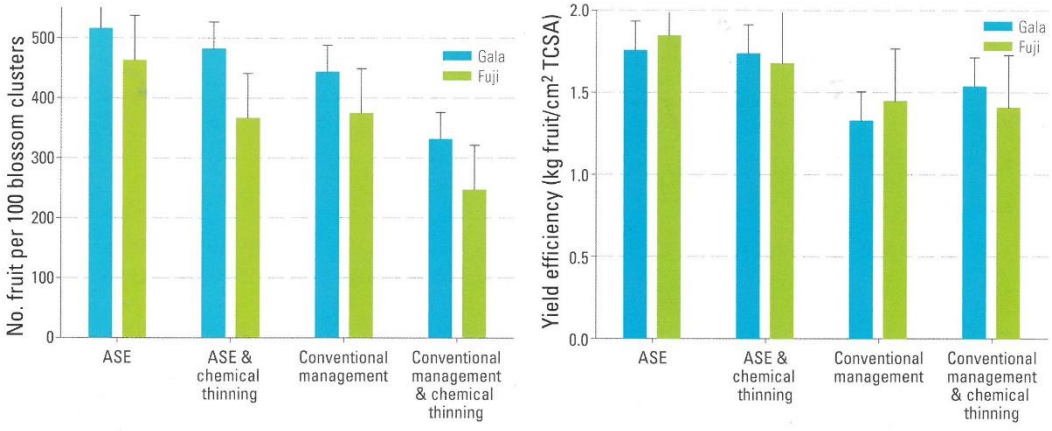
Hand thinning is simplified because spacing, position and number of clusters are already set by the bud thinning process – all that is required is to break up fruit bunches and remove fruit with defects.

The effects of crop load management methods on the number of fruit set per floral bud.



The proportion of buds setting multiple fruit was higher in ASE managed trees than in the conventionally managed trees.

▶ Fruit set (left) and Yield efficiency (right) under different crop load management methods.



There were fewer flower buds in the ASE managed trees, but the percentage of fruit set was higher than in the conventionally managed trees. The amount of fruit produced per cm² of trunk cross-sectional area was more than 20 per cent higher in the ASE managed trees.

Trial design and treatments

In the study reported here, treatments were ASE or conventional hand thinning plus or minus a chemical thinning regime. Floral buds were thinned to six buds per cm² of limb cross-sectional area (LCSA) on the ASE trees in late August just prior to bud break.

A full chemical thinning program, using the bloom thinners Ethrel® (ethephon) and NAA and post-bloom thinner Maxcel® (BA), was undertaken following the program normally used for each block. All trees were hand-thinned nine weeks after full bloom (FB), following natural fruit drop, to six fruit per cm² of LCSA. Fruit was harvested at normal commercial harvest.

Influence of tree structure on flower number and fruit set

In ASE managed trees, the number of flower buds (clusters) is reduced prior to bud burst, resulting in fewer buds than in conventionally managed trees.

Conventional trees carried approximately double the number of flower buds at bud break compared with the ASE managed trees. A high proportion of clusters set fruit in these trials – the result of an unusual season.

> ASE is a suitable tool for managing crop load without additional chemical thinning.

However the addition of chemical thinning had no effect on ASE managed trees, while in conventionally managed trees, the proportion of clusters set was significantly reduced in both Gala and Fuji, with the greatest effect in Fuji.

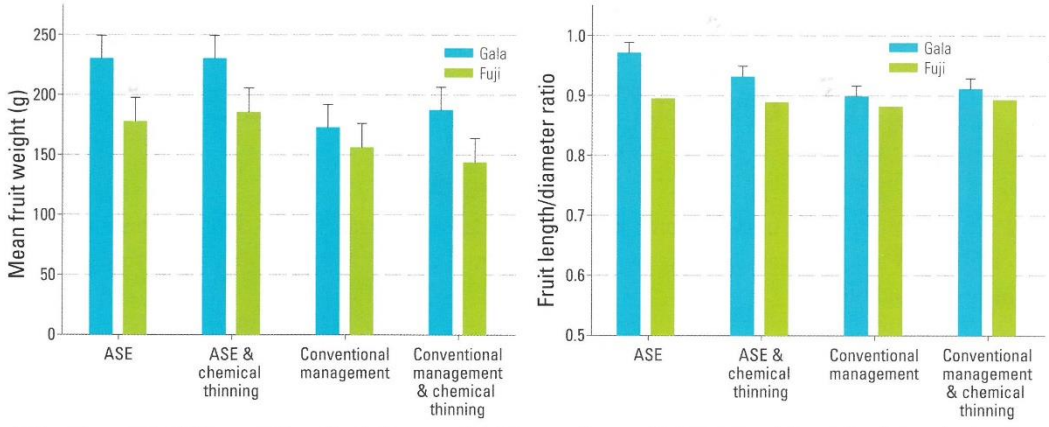
Although varying from year to year, under conventional tree management it is not uncommon that 30 to 50 per cent of spur and terminal buds fail to set fruit. Weather conditions in 2015 led to an extremely high fruit set in the Huon Valley where the trials were located. However, the proportion of buds setting multiple fruit was higher in ASE treatments than in the conventionally managed trees.

Even though the number of flower buds was reduced in the ASE managed trees, the percentage of fruit set was higher than in conventional trees. This is explained by a high percentage of clusters setting fruit with a higher proportion of multiple fruit set in each cluster. These results are in agreement with our earlier work showing that most floral buds set fruit under ASE management, most likely due to stronger buds and less competition for resources.

Yield efficiency (kg of fruit per cm² trunk cross-sectional area) was improved by over 20 per cent in the ASE managed trees in both cultivars. Chemical thinning had no effect on yield efficiency of ASE managed trees, but in the conventional trees chemical thinning slightly improved efficiency in Gala but not Fuji.

Fruit was larger in the ASE than in the conventionally managed trees in both Gala and Fuji. Although all trees were hand-thinned to the same crop loads in early December, initial fruit set in the conventional trees was reduced by chemical thinning but there was no corresponding increase in fruit size as would be expected with a lower crop load. So while these trees were carrying less fruit in the period between fruit set and hand-thinning, as both ethephon and NAA are known to impair fruit size, even if thinning occurs, it appears that the chemical thinners may have negatively affected fruit size. ▶

▶ The effects of the different treatments on fruit weight (left) and fruit shape (right) in Gala and Fuji.



Fruit was larger in the ASE managed trees than in the conventionally managed trees and fruit shape was influenced by the crop load management method in Gala but not Fuji.

Fruit shape (measured as fruit length to diameter ratio) was influenced by the crop load management regime in Gala but not Fuji. Shape was significantly improved with ASE management compared with conventional and, similarly to fruit weight, it appears that the addition of chemical thinners to these trees negatively affected Gala fruit shape; ethephon in particular is known to flatten fruit.

Cytolin® is commonly used to improve fruit shape and size in Gala, so if the improved fruit shape observed in ASE managed trees is shown to be consistent from year to year, then the application of Cytolin may no longer be necessary.

Conclusions

The lack of effect of chemical thinning in further reducing crop load on ASE managed trees demonstrates that ASE is a suitable tool for managing crop load without additional chemical thinning. There is also the added negative impact of chemical thinners on fruit size and shape.

Although this study will continue for the coming season, providing another season of data, including a cost-benefit analysis, early results indicate the potential of ASE to supersede and eliminate the present requirements for chemical thinning to regulate biennial bearing and crop loading.

Using ASE to manage crop load has the added advantage that the achievement of target crop loads is no longer dependent on unpredictable weather conditions during the flowering and post-bloom periods when thinners are normally applied.

In addition, bud position is optimised in ASE, fruit is well spaced and light distribution into the canopy is enhanced. With this technology growers are also able to set their trees up to carry a pre-determined crop load with reasonable accuracy, thus enabling improved management of fruit size.

Implementation of ASE and a move away from chemical thinning, combined with simplified hand-thinning and more even fruit maturity will reduce both time and cost to the grower, but will require a paradigm shift.

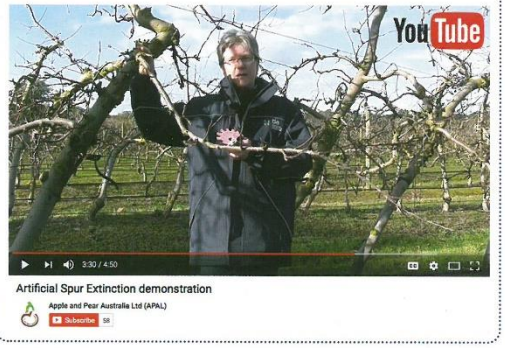
The chemicals Ethrel®, Cytolin®, NAA and Maxcel® are registered for use on some apple varieties in Australia. The list of registered products and permits for apple production are available on the Australian Pesticide and Veterinary Medicine Authority website: www.apvma.gov.au. :afg

Acknowledgement

Thanks to Scott Price, manager of Calvert Brothers Rookwood orchard at Ranelagh, for use of his orchard and provision of trial trees. The PIPS 1 project team of Stuart Tustin, Ben van Hooijdonk and Ken Breen (Plant & Food Research, NZ); Simon Middleton, John Wilkie and Heidi Parkes (DAF Queensland); and Dugald Close who paved the way for this work with the initial study comparing ASE and conventional management.

This project is funded by Horticulture Innovation Australia Ltd using the apple and pear industry levy paid by growers and matched funds from the Australian Government.

Watch Sally demonstrate ASE on APAL's YouTube channel: tinyurl.com/APALyoutube.



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(ii) Article published in Australian Fruit Grower, Vol 11, Issue 4, pp 33-35, Aug/Sept 2017

Precision crop load management without chemicals

By Dr Sally Bound

In the lead-up to spring, University of Tasmania researcher Sally Bound updates us with the latest and very promising results from her research identifying how to use Artificial Spur Extension to manage crop load and get better production results.

Last year we reported on the preliminary results of a two-year study that was established to better understand how Artificial Spur Extinction (ASE) could be used in Gala and Fuji. In particular, we wanted to see if ASE could reduce extreme biennial bearing and reduce chemical thinning without compromising fruit yield and quality. This work was part of the PIPS Orchard Productivity Program, a strategic levy investment under the Hort Innovation Apple and Pear Fund.

The first year's results were promising and gave us evidence to support that ASE may be a better tool for managing crop load without additional chemical thinning than current standard practices (see Are chemical thinners necessary? *Australian Fruitgrower* Oct/Nov 2016).

Here is the report on the second year's results from the trial that further support the case that ASE could deliver better results and reduce costs if adopted by growers.

About the trials

We established trials in commercial orchards in Tasmania to test how the following practices compared: ASE, ASE with chemical thinning, conventional pruning and conventional pruning with chemical thinning.

All trees were pruned during winter; unbalanced limbs were removed and then remaining limbs were spaced out to six limbs per metre of tree height. On the ASE trees, floral buds were thinned to six buds per cm² limb cross-sectional area (LCSA) in late August just before bud break. A full chemical thinning program, using the bloom thinners Ethrel® (ethephon) and NAA and post-bloom thinner Maxcel® (BA), was undertaken on trees tagged for chemical thinning. Following natural fruit drop, all trees were hand-thinned nine weeks after full bloom to six fruit/cm² limb cross-sectional area (LCSA). Fruit was harvested at normal commercial harvest.

Results

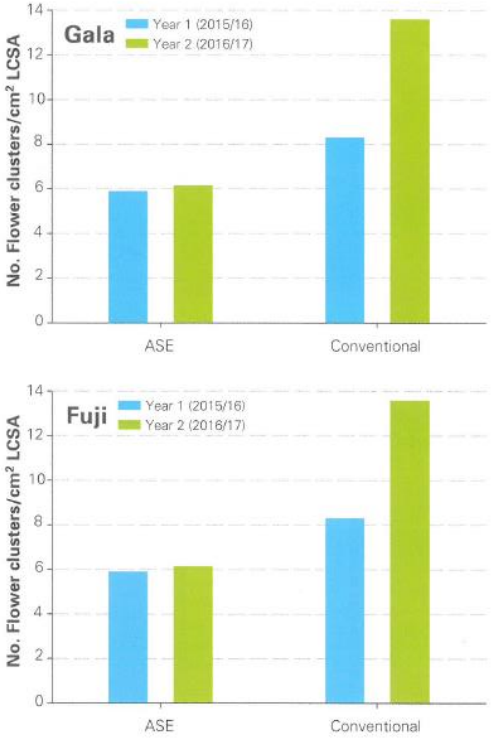
Flowering

In ASE-managed trees the number of flower buds (clusters) was reduced before bud burst, resulting in fewer buds than in conventionally managed trees. Conventional trees were carrying approximately double the number of flower buds at bud break compared with the ASE-managed trees. The other important point to note is that the number of clusters in the ASE trees was stable across the two years.

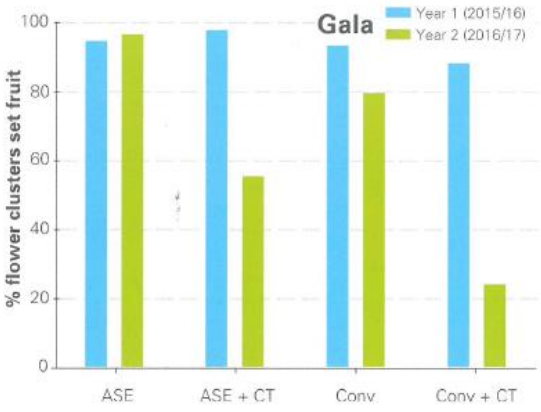
What is Artificial Spur Extinction?

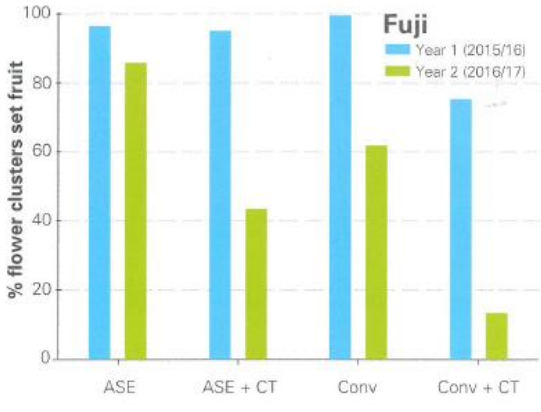
Artificial Spur Extinction (ASE) is a crop load management method using bud-thinning techniques to precisely define where and how much fruit is set on each limb of the tree. The aim of ASE is to promote the vigour and performance of floral spurs, stimulate spur strength and improve fruit quality and regularity of production.

Number of flower clusters per cm².



▶ **Proportion of flower clusters that set fruit**





Fruit set

In the first year (2015/16), a high proportion of clusters set fruit, which was the result of an unusual season with a very short and compressed flowering period. Flowering in the second season (2016/17) was spread over a longer period of about four weeks and a more conventional pattern of fruit set was observed. Chemical thinning reduced the proportion of clusters set in both Gala and Fuji.

Under conventional tree management it is not uncommon to see 30-50 per cent of spur and terminal buds fail to set fruit. Even allowing for the unusual spring in 2015, the proportion of buds setting multiple fruit was higher in ASE treatments than in the conventionally managed trees, and this effect was even more marked in the second season.

Even though the number of flower buds was reduced in the ASE-managed trees, the percentage of fruit set was higher than in conventional trees. This is explained by a high percentage of clusters setting fruit with a higher proportion of multiple fruit set in each cluster. These results are in agreement with our earlier work showing that most floral buds set fruit under ASE management, most likely due to stronger buds and less competition for resources. Chemical thinning was more effective in the second year of the study, reducing fruit numbers by approximately half across all treatments.

Yield

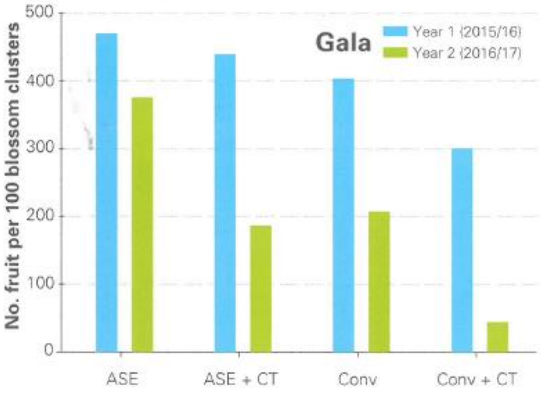
In Year 1 of this study, total yield was about 60 t/ha in the Gala for all treatments, with chemical thinning having no real effect. In Fuji, yield was 30 per cent higher in the ASE trees than in the conventional, and chemical thinning further reduced yield in both cultivars. In the second year, ASE produced higher yields in both cultivars.

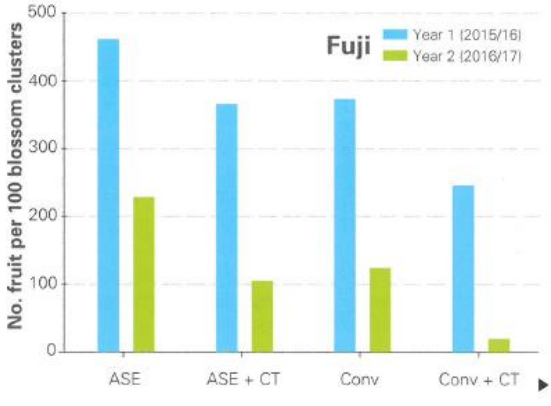
ASE delivered superior benefits

ASE is a suitable tool for precision management of crop load without additional chemical thinning. It has marked advantages in that it is not weather dependent and it removes the negative impact that most chemical thinners have on fruit size and shape.

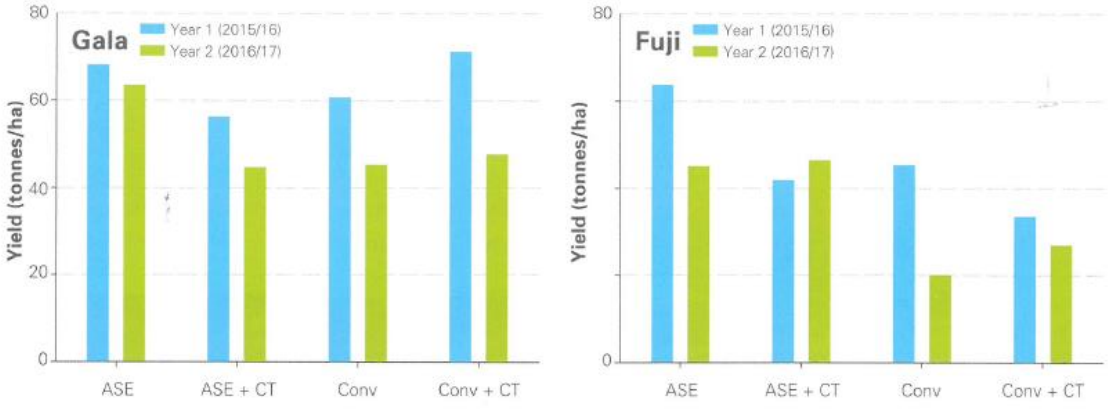
In addition, bud position is optimised in ASE, fruit is well spaced and light distribution into the canopy is enhanced. With this technology growers are also able to set their trees up to carry

Fruit set





▶ **Yield**



a pre-determined crop load with reasonable accuracy, thus enabling improved management of fruit size.

A full cost:benefit analysis is still to be completed, taking into account time of pruning and bud removal, cost of spraying, hand thinning etc., but our results indicate the potential of ASE to supersede and eliminate the present requirements for chemical thinning to regulate biennial bearing and crop loading.

Although the first year of ASE implementation can be labour-intensive, in the longer term the application of ASE with its simplified hand-thinning and more even fruit maturity, combined with a move away from chemical thinning, is likely to reduce both time and cost to the grower. :afg

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This project is funded by Hort Innovation using the apple and pear levy and funds from the Australian Government.

> "…our results indicate the potential of ASE to supersede and eliminate the present requirements for chemical thinning to regulate biennial bearing and crop loading."

(iii) Article submitted for publication in Australian Fruitgrower Feb/March 2018:

New tool for precision crop load management

Dr. Sally Bound, Senior Research Fellow, Perennial Horticulture Centre, Tasmanian Institute of Agriculture, University of Tasmania

Previous articles on ASE (see Are chemical thinners necessary? *Australian Fruitgrower* Oct/Nov 2016, and Precision crop load management without chemicals *Australian Fruitgrower* Aug/Sept 2017) have demonstrated that ASE is a suitable tool for precision management of crop load without the need for additional chemical thinning. But what about the cost of implementation is the question being asked by many growers.

Here the results of a larger semi-commercial scale demonstration trial on Buckeye Gala are discussed, along with a cost comparison between ASE and chemical thinning, providing further evidence to support the benefits of ASE in delivering better results, removing the need for chemical thinning without compromising fruit yield and quality, and reducing costs.

Demonstration site

The demonstration site was established at Rookwood orchard, Ranelagh in Tasmania's Huon Valley and involved five different regimes:

1. Setup prune (SP) + ASE
2. SP + ASE + chemical thinning (CT)
3. Grower prune (GP) + ASE
4. GP plus ASE + CT
5. Standard (GP + CT)

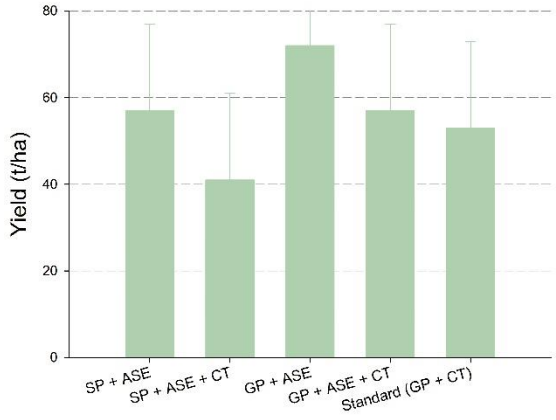
As most growers tend to leave more limbs in the tree than is recommended for ASE, we included two different pruning regimes to allow us to compare these differences. The setup pruning in regimes 1 and 2 reduced the number of limbs down to a maximum of 6-7 limbs per metre of tree height, tied down upright limbs to a more horizontal position and removed spurs and small twiggy branches from the main trunk, compared with the grower prune which had 9-10 limbs per metre of tree height and the main trunk was left untouched. This meant that regimes 1 and 2 had less wood, allowing more light into the tree.

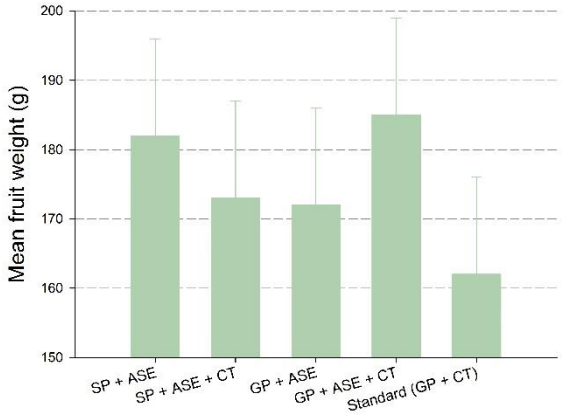
The chemical thinning program consisted of bloom applications of Ethrel® (ethephon) and NAA and a post-bloom tank mix application of Maxcel® and carbaryl.

Impacts on yield and fruit quality

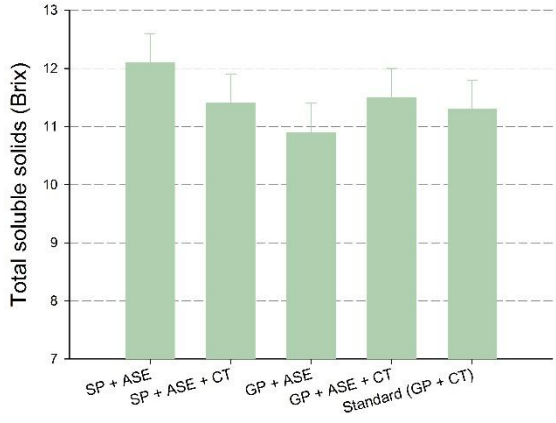
Yield in the ASE regime was 57 t/ha, slightly higher than the 53 t/ha achieved in the standard chemical thinned regime. Chemical thinning reduced yield by 16 t/ha in the ASE regime and 15 t/ha in the grower pruned plus ASE regime.

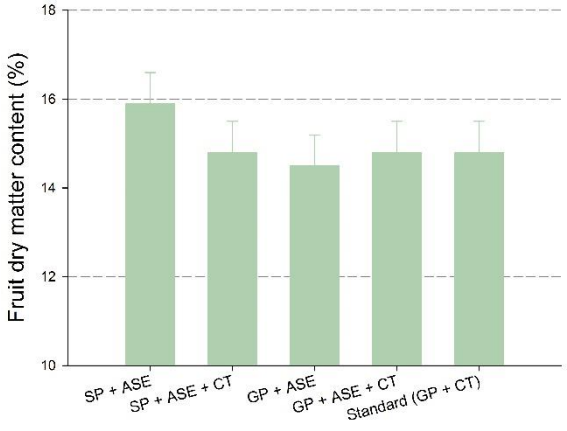
Even though yields were similar, average fruit weight was considerably reduced in the standard regime (162 g) compared with the ASE regime (182 g). This is a result of reducing the number of flowering sites early in the season, thus reducing competition for resources. Yield was highest in the GP + ASE regime (72 t/ha), but fruit quality was reduced.

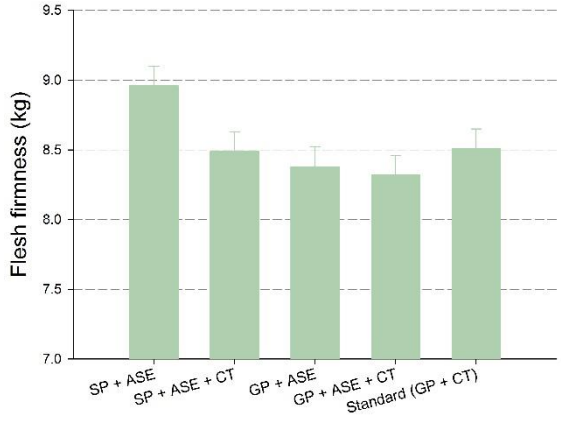




The highest quality fruit was produced in the ASE regime - soluble solids content (SSC) 12.1°Brix, dry matter content (DMC) 15.9% and firmness 8.96 kg. The standard regime resulted in SSC of 11.3°Brix, 14.8% DMC and firmness reading of 8.51 kg, while the GP + ASE regime fruit had 10.9°Brix SSC, 14.5% DMC and 8.38 kg firmness.







When it came to hand-thinning, the standard trees took 50% longer to thin than the ASE due to the heavier crop load, and the GP + ASE took 22% longer as there were more branches in the trees.

Hand thinning of ASE-managed trees is very simple, as spacing, position and number of clusters are already determined – all that is required is to thin the clusters to singles. Chemical thinning is very much hit and miss, with no control over where fruit are positioned on the tree, and the decision needs to be made on which clusters to retain. Even though most flower clusters set fruit, ASE-managed trees do not express late fruitlet drop as there is no excessive fruit set that invokes fruit-shedding, so hand-thinning to adjust crop load to the final desired numbers can be started within 3–4 weeks of flowering rather than waiting for fruit drop in December.

Cost comparison

To compare the costs of the different regimes, the time taken to prune, complete the ASE setup (bud removal) and hand-thin were recorded and used to calculate the cost per hectare of each activity based on a labour cost of $25 per hour. The chemical thinning cost includes the cost of chemicals, labour at $25 per hour and a machinery cost of $25 per hour for the tractor/sprayer.

The first year of ASE implementation is the most labour intensive as it involves some restructuring of trees, and removing buds across the entire tree. In subsequent years, pruning is reduced to the level that would normally be undertaken in the orchard and it is only necessary to remove buds on new wood, thus further reducing costs.

(i) Year 1 *(initial ASE implementation)*	Costs ($/ha)				
	Pruning	ASE setup	Hand-thinning	Chemical thinning	**Total**
SP + ASE	2,604	2,604	5,208	-	**10,417**
SP + ASE + CT	2,604	2,604	4,688	623	**10,519**
GP + ASE	1,823	2,865	6,354	-	**11,042**
GP + ASE + CT	1,823	2,865	6,250	623	**11,561**
GP + CT (standard)	1,823	-	7,813	623	**10,258**

(ii) Year 2

ASE	1,823	1,302	5,208	-	**8,333**
Standard (GP + CT)	1,823	-	7,813	623	**10,258**

SP = setup prune, ASE = Artificial Spur Extinction, GP = grower prune, CT = chemical thinning

The cost of implementing ASE in an established orchard is similar to the cost of a standard chemical thinning program, and once the trees are set up, the cost of crop load management drops. It should be noted that the cost of implementation will vary depending on the age and structure of the trees. However, there is the added benefit that trees can be set up with a pre-determined crop load with reasonable accuracy, thus enabling improved management of fruit size. In addition, bud position is optimised in ASE, fruit is well spaced and light distribution into the canopy is enhanced.

Grower perspective

Having watched the progress of the ASE studies over the last few years, Scott Price from Rookwood Orchard is keen to revisit spur extinction on the orchard. He suggests that most growers think that chemical thinning is doing a good job and are reluctant to change a system that they perceive is doing a great job for them. However the reality is that chemical thinning is unreliable and fruit quality is below optimum. Chemical thinning has certainly served the industry well over the last few decades, but modern techniques such as ASE enable precision management of crop load, something that has been missing with chemical thinning. According to Scott, many growers are subconsciously doing spur extinction to a greater or lesser degree, especially on Gala, but he agrees that use of ASE for crop load management is a new paradigm requiring a different mindset. He also pointed to growers in the Shepparton area, such as Maurice Silverstein who have successfully implemented ASE as a crop load management tool.

Conclusions

ASE offers a new technology to precisely manage crop load. Bud numbers are set in late winter, so trees are significantly thinned before flowering, with buds optimally placed and spaced. Because ASE-managed trees carry fewer but stronger flower buds than conventional trees, more resources are directed into these buds, resulting in improved fruit quality. ASE eliminates the need for chemical thinning and has the added advantages that it is not weather dependent and removes the negative impact that most chemical thinners have on fruit size and shape.

Yes, moving away from chemical thinning for crop load management requires a change in mind set, but with its simplified hand-thinning and high fruit quality, ASE will reduce both time and cost to the grower.

Acknowledgements

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Appendix 6 – Other publications

Fact sheet available on the TIA website:
http://www.utas.edu.au/__data/assets/pdf_file/0006/978099/Chemical-free-crop-load-apples.pdf

tia
TASMANIAN INSTITUTE OF AGRICULTURE

utas.edu.au/tia

Perennial Horticulture Fact Sheet

Key Points

- ASE is a suitable tool for precision management of crop load without additional chemical thinning.
- ASE management is not weather dependent and precisely spaces fruit for optimum light distribution.
- ASE managed trees set more multiple fruit and achieved a higher percentage fruit set than conventional trees.
- ASE managed Gala and Fuji trees produced up to 30% higher fruit yield in a typical flowering season.

Chemical free crop load management

There is strong interest in finding alternatives to thinning apples with chemicals. Fickle spring weather can make chemical thinning of apples tricky with often unpredictable results. Environmental concern about some thinning chemicals is also prompting a rethink around their use.

Artificial Spur Extinction (ASE) is a crop load management method showing promise as an alternative to chemical thinning. This study expands on initial work that demonstrated ASE as a feasible crop load management option. It investigates its effectiveness with the cultivars Fuji and Gala and compatibility with chemical thinning.

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What is Artificial Spur Extinction?

Artificial Spur Extinction (ASE) is a crop load management method that uses bud thinning techniques to precisely define where and how much fruit is set on each limb of the tree. The aim of ASE is to promote the vigour and performance of floral spurs, stimulate spur strength and improve fruit quality and regularity of production.

Research questions

1. Is ASE effective on cultivars with an extreme biennial bearing tendency, such as 'Fuji'?
2. How do ASE managed trees respond to chemical thinners?
3. Can ASE technology be successfully merged with chemical thinning to optimise yields and fruit quality?
4. How does ASE technology compare directly with best practice chemical thinning programs in terms of yield, pack-outs, and cost:benefit?

Flowering and fruit set

In spring, ASE managed trees are already significantly thinned, carrying around half the number of flower buds of conventional trees. With less competition more resources are directed to fruit buds that go on to produce fruit rather than thinnings on the ground.

ASE trees set more multiple fruit

ASE managed trees carried a greater proportion of buds that set multiple fruit set. This effect was even more marked in the 2016/17 season where the flowering period was extended over 6 weeks.

ASE trees set more fruit

ASE managed trees achieved a higher percentage of buds setting fruit than conventional trees, despite having fewer total flower buds.

About the trial

Year 1: 2015/16 , an unusual season with flowering compressed to a very short time (5 days).
Year 2: 2016/17, a more conventional season with flowering occurring over 6 weeks.

ASE treatment
Floral buds thinned to 6 buds cm^{-2} limb cross sectional area (LCSA) in late August.

Chemical thinning treatment
A full program using bloom thinners Ethrel® (ethephon) and NAA and post bloom thinner Maxcel® (BA).

ASE increases fruit yield

Seasonal conditions and variety influenced the effectiveness of the different crop load management strategies. ASE managed trees produced the highest yields in Year 2 for both Gala and Fuj, (Figure 1).

In the highly compressed flowering season of Year 1, Gala yields were similar irrespective of management. However, Fuji responded strongly to ASE with a 30% higher yield than for conventional or chemically thinned trees.

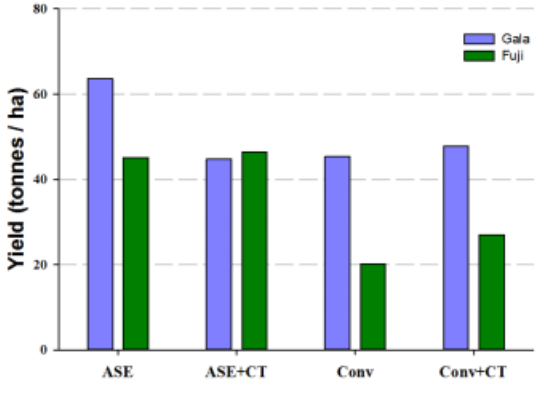

Figure 1. *Yield of 'Gala' and 'Fuji' under different crop load management regimes in 2016-17. ASE = Artificial Spur Extinction, CT = chemical thinning*

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