Development of improved chemical thinning practices in canning peaches

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Agrisearch Services Pty Ltd

Project Number: CF07005

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This report is published by Horticulture Australia Ltd to pass on information concerning horticultural research and development undertaken for the canning fruit industry.

The research contained in this report was funded by Horticulture Australia Ltd with the financial support of Canned Fruits Industry Council of Australia, Agrisearch Services Pty Ltd, Bayer CropScience and NuFarm Australia Limited.

ISBN 0 7341 2716 2

Published and distributed by:
Horticulture Australia Ltd
Level 7
179 Elizabeth Street
Sydney NSW 2000
Telephone: (02) 8295 2300
Fax: (02) 8295 2399

Horticulture Australia

CF07005
(21 December 2011)

DEVELOPMENT OF IMPROVED THINNING PRACTICES IN CANNING PEACHES

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This final report provides details of the studies undertaken to develop improved thinning practices in canning peaches.

This project has been funded by HAL using voluntary contributions from the canned fruits industry council of Australia and matched funds from the Australian Government.

Please consult the APVMA website (http://www.apvma.gov.au) for the most up to date information regarding the registration or minor use access status of any of the chemicals discussed within this report.

21 December 2011

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1. MEDIA SUMMARY

In Victorian canning peach orchards, fruit thinning has been traditionally practiced by hand. This is expensive, costing up to $3,000 per hectare, and has often been done too late to achieve maximum benefit in achieving optimum fruit yields.

Field trials conducted by Agrisearch Services Pty Ltd and reported in 2001 (FR96001) demonstrated that the blossom desiccant ammonium thiosulphate (ATS) was an effective fruit thinning agent in canning peaches, leading to larger fruit size at harvest compared to hand thinning alone. Agrisearch recommended the use of ATS (in combination with a suitable non-ionic wetting agent), as a single application, at around 70-90% flowering. However uptake by the industry was not widespread, due to a fear of over thinning and a perception of unreliability. Research by Bound et al (2005) in apples indicated that multiple applications of ATS, without the addition of a wetting agent and using slightly lower dosages, could be more effective than a single application at higher rates applied late in the flowering period.

This project aimed to refine the application regime for ATS to improve reliability in efficacy and to reduce the risk of over thinning giving growers greater confidence in using this product.

A range of field studies were conducted over four seasons on commercial canning peach orchards across the Goulburn and Murray Valleys. Flowering patterns in the key canning peach cultivars, Tatura 204, Tatura 211 and Golden Queen were studied in year 1 to better understand variability within and between trees and determine if there was variability between cultivars. Field trials evaluated application frequency, timing and method in orchards with varying tree architecture over multiple seasons. Two different spraying systems were included; conventional air blast application and directed application through a Quantum mist sprayer.

ATS when applied as a split application at around 40-60% flowering and again around 70% flowering to full bloom, at 1% v/v, in Tatura 211 and Golden Queen was shown to be consistently more effective than a single application, whilst in Tatura 204 an application rate of 1.5% v/v was required to achieve effective thinning. The application of ATS through a Quantum mist sprayer generally provided better efficacy than the same rate applied through a conventional airblast sprayer. Dollar savings from reduced thinning time were considerable, but were offset somewhat by the cost of chemical and application. However if early thinning is optimised, gains in fruit size could lead to increased returns of up to $6,000/ha.

The use of ATS however forms only part of an integrated approach which is required to achieve effective crop load management. Smart pruning and chemical thinning followed by timely hand thinning will result in maximum yields being consistently achieved. A program to improve understanding of the need for accurate product application, selection of appropriate use rates and determining when crops are at the correct stage for spraying, is recommended.

Data from this project will be used to establish a label extension for use of ATS in specific canning peach varieties using the new rates and application methods.

2. TECHNICAL SUMMARY

In Victorian canning peach orchards, fruit thinning has been traditionally practiced by hand. Field trials conducted by Agrisearch Services Pty Ltd and reported in 2001 (FR96001) demonstrated that the blossom desiccant ammonium thiosulphate (ATS) was an effective fruit thinning agent in canning peaches, leading to larger fruit size at harvest compared to hand thinning alone. Agrisearch recommended the use of ATS (in combination with a suitable non-ionic wetting agent) as a single application, at around 70-90% flowering. However uptake by the industry was not widespread, due to a fear of over thinning and a perception of unreliability.

Research by Bound et al (2005) in apples indicated that multiple applications of ATS, without the addition of a wetting agent and using slightly lower dosages, could be more effective than a single application at higher rates applied late in the flowering period.

This project aimed to refine the application regime for ATS to improve reliability in efficacy and to reduce the risk of over thinning and crop phytotoxicity giving growers greater confidence in using this product. Using the results from FR96001 and from work conducted in New Zealand (Latter – personal communication) an application rate of 1% v/v was determined as the optimum to maximise efficacy and minimise crop phytotoxicity.

A range of field studies were conducted over four seasons on commercial canning peach orchards.

In year 1 of the project flowering patterns in three key canning peach cultivars were studied. In each of the selected blocks 20 trees were monitored for the time of flower opening, at three levels in the canopy, across the whole flowering period. An attempt was made to determine the maximum number of flowers which may be susceptible to ATS at any stage during the flowering period. Historical data on flowering times were collected and attempts made to correlate this with winter chill and environmental conditions. However, no conclusive data were uncovered.

Nine small plot replicated field trials were completed in years 1 and 2 of the study. ATS was applied at three different timings/schedules, in volumes of 500-100 L/ha, through both a Quantum mist and conventional airblast spray unit.

In years 3 and 4 a further eight large block studies were conducted to confirm the efficacy from the earlier application regimes in Tatura 211 and Golden Queen; and to further investigate using higher application rates of ATS in Tatura 204 to achieve effective thinning.

Treatments were applied at the appropriate timings using conventional airblast or a purpose built Quantum mist sprayer in a range of volumes between 500 and 1100 L/ha. The Quantum mist sprayer delivers the spray from nearer the target and from a different spray angle than the traditional airblast unit.

Assessments for fruit set based upon pre-spray flower counts and post-spray fruit set counts were completed in most trials. The effect of efficacy on fruit development was assessed at stone hardening and harvest. In addition, thinning time and total yield assessments were also completed in year 4.

The results from flowering pattern studies indicate a high level of variability within blocks meaning that accurate assessment of flowering must be undertaken to ensure that application timing is accurate. However these assessments also confirmed that if an appropriate rate of ATS was used at any stage of the flowering period, then there was little risk of over thinning as there will always be some flowers which are not at the susceptible stage of development.

ATS when applied as a split application at around 40-60% flowering and again around 70% flowering to full bloom at 1% v/v, in Tatura 211 and Golden Queen, was shown to be consistently more effective than a single application.

In Tatura 204 an application rate of 1.5% v/v was required to achieve effective thinning. A split application regime is recommended for this variety as well.

The application of ATS through a Quantum mist sprayer generally provided better efficacy than the same rate applied through a conventional airblast sprayer.

The study has clearly shown that when used at an application rate of 1-1.5% v/v, without the addition of a surfactant, in a spray volume of 700-1000 L/ha, ATS was safe to canning peaches, with no risk of over thinning.

Dollar savings from reduced thinning time were considerable, but were offset somewhat by the cost of chemical and application. However if early thinning is optimised, gains in fruit size could lead to increased returns of up to $6,000/ha.

The use of ATS however forms only part of an integrated approach which is required to achieve effective crop load management. Smart pruning and chemical thinning followed by timely hand thinning will result in maximum yields being consistently achieved.

A program to improve understanding of the need for accurate product application, selection of appropriate use rates and determining when crops are at the correct stage for spraying, is recommended.

Data from this project will be used to establish a label extension for use of ATS in specific canning peach varieties using the new rates and application methods.

3. INTRODUCTION

In Goulburn and Murray Valley canning peach orchards, fruit thinning has been traditionally practiced by hand. This is expensive, costing up to $3,000 per hectare, and has often been done too late to achieve maximum benefit in achieving optimum fruit yields.

Field trials conducted by Agrisearch Services Pty Ltd under project FR96001 (and reported in 2001) demonstrated that the use of the blossom desiccants ammonium thiosulphate (ATS) and Armothin, and the synthetic gibberellin Ralex, were effective fruit thinning agents in canning peaches leading to corresponding increases in fruit size.

Uptake by the industry however was not widespread due to a perception of unreliability when using these products, with repeatable efficacy and crop safety being an issue and a fear of over thinning. This led to limited adoption. In addition, manufacturers had been reluctant to invest in further R&D to refine the application parameters.

Armothin and Ralex were also seen by industry as being relatively expensive compared to ATS and generally offered no better performance.

The general consensus within the canning fruit industry was that ATS offered the most promising and cost effective option for a chemical thinning product.

Recommendations from project FR96001 were to use ATS (in combination with a suitable non-ionic wetting agent), as a single application, through a conventional airblast sprayer, at around 70-90% flowering. By delaying the timing of this application it was considered that a large percentage of the flowers would have set fruit, then the application would remove a significant proportion of the later flowers. However it has since been noted that this approach could lead to variable results because of differences in tree size and architecture, different spraying equipment between orchards and a lack of understanding of the actual stage of flowering development.

Research by Bound et al (2005) in apples indicated that multiple applications of ATS, without the addition of a wetting agent, and using slightly lower dosages could be more effective than a single application at higher rates applied late in the flowering period. Some on farm adoption of this regime in canning peaches had been undertaken and anecdotally seemed to be effective.

This project was then adopted to refine the application regime for ATS to:

- Improve reliability in efficacy with ATS for use in canning peaches.
- Refine product application and rates to reduce the risk of over thinning and crop phytotoxicity to give growers greater confidence in using this approach.

This project was formulated based upon these aims and included the following components:

Project Component 1 – Develop a Better Understanding of Application Timing

Under this part of the project flowering patterns in key canning peach cultivars were studied. Historical data on flowering times were collected and attempts made to correlate these with winter chill and environmental conditions during the flowering period. However, no conclusive data were uncovered relevant to local conditions, so a program of flower mapping was undertaken in key canning peach cultivars in year 1 of the study.

Project Component 2 – Development of a Repeatable Application Regime for ATS in Canning Peaches

Field trials were undertaken in each of the four years of the study to evaluate application frequency, timing and method in orchards with varying tree architecture and their impact over multiple seasons under varying environmental conditions.

In addition two different spraying systems were evaluated, namely conventional air blast application and low volume directed application through a Quantum mist sprayer. Mechanical blossom thinning was also included in some experiments to compare this thinning option with chemical thinning via ATS.

Initially small plot replicated studies were completed, then later in the project large block studies were conducted to evaluate commercial possibilities.

In addition, field days were held in each season to demonstrate various chemical thinning options to growers and presentation of results were made to canning fruit growers' meetings at each season's end.

Project Component 3 – Canning Fruit Thinning Manual

A grower resource document has been prepared detailing options for fruit thinning in canning peaches.

In addition, field days were held in each season to demonstrate various chemical thinning options to growers and presentations of results were made to canning fruit growers' meetings at each season's end.

The project was conducted under Horticulture Australia Limited project CF07005 and Agrisearch Project HAL/09/02.

4. MATERIALS AND METHODS

4.1 Project Component 1 – Flower Mapping

The conduct of the flower mapping studies was aimed at determining the numbers of flowers which may be susceptible at any time during the flowering phase, and if there was a possibility of over thinning occurring if the application rate was at a level which would not cause shoot burn. The variance in flowering pattern between varieties, then within trees and between trees within the same block of each variety were also important parameters which were considered. Byers (1989) suggested that germination time can take between 24 and 72 hours to complete depending upon temperature and other factors. In the mapping process conducted the following assumption was made: unopened flowers were not susceptible to ATS, open flowers with all petals attached were susceptible, flowers with 2 or more petals dislodged were either pollinated or past the susceptible stage.

4.1.1 Site Details

Block Number	Variety	Location	Tree Age	Planting Configuration	Training Method	Tree Size
1	Tatura 204	Invergordon	12 years	3 m x 5.5 m	Open centre vase	4 metres
2	Tatura 211	Invergordon	8 years	3 m x 5.5 m	Open centre vase	4 metres
3	Golden Queen	Invergordon	5 years	3 m x 5.5 m	Open centre vase	3 metres

4.1.2 Tree Selection

One block of each variety, of between 0.5 and 1.0 ha, was selected. Trees were aged between 8 and 12 years and each block was considered to be mature and in full production.

Commencing at bud swell, 20 trees were tagged within each block for assessment. Trees were selected on a grid pattern so that an even distribution across each block was achieved for assessment.

4.1.3 Flower Monitoring

On each of the 20 selected trees, two even sized and main bearing limbs were tagged for assessment. Each limb was divided into three main sections, namely the top, middle and bottom thirds of the branch. Then at the early pink stage, the total number of flowers on each section of tagged branch was recorded.

Blocks were monitored for the date of first flower opening, then each tree was inspected every 2-4 days for the duration of the flowering period and the number of newly opened flowers, and the number of flowers on which petals had fallen, were recorded.

Data are presented making the assumption that flowers on which petals had fallen, had been pollinated or were no longer susceptible to ATS sprays.

Results are given as the percentage of flowers open that were considered susceptible to ATS.

Flowering patterns were not monitored during ensuing years of the project however the flowering duration was. The approximate date of 20% flowers open and full bloom were recorded and referenced to determine the length of the application window across multiple seasons.

4.2 Project Component 2 – Efficacy Studies

4.2.1 2007/2008 Trials

The initial recommendation of using ammonium thiosulphate (ATS) in combination with a non ionic surfactant, at a single application timing, has since been considered to be inappropriate. Research by Bound et al (2005) in apples indicated that multiple applications of ATS, without the addition of a wetting agent, and using slightly lower dosages could be more effective than a single application at higher rates late in the flowering period. Some on farm adoption of this regime in canning peaches had been undertaken and anecdotally seemed to be effective. Based upon the previous studies conducted by Agrisearch (FR96001) evaluating a range of application rates, the work of Bound et al in apples and private discussion with Gro-Chem, the manufacturer of THIN-IT (ATS), the target rate to achieve this objective was considered to be 1% v/v.

Thus the program initiated in 2007/08 concentrated on comparing the efficacy of multiple applications of ATS, at varying timings, with a single application late in the flowering period, which had been previously recommended.

4.2.1.1 Site Details

Trial Number	Variety	Location	Tree Age	Planting Configuration	Training Method	Tree Size
1	Tatura 204	Invergordon	12 years	3 m x 5.5 m	Open centre vase	4 metres
2	Tatura 211	Invergordon	8 years	3 m x 5.5 m	Open centre vase	4 metres
3	Golden Queen	Invergordon	5 years	3 m x 5.5 m	Open centre vase	3 metres

4.2.1.2 Treatments

Trial 1

Treatment	Rate (Product % v/v)	Application Timing (% Bloom)
1. ATS	1%	70-90%
2. ATS	1%	50%+70-90%
3. Untreated Control	-	-
4. Untreated Control	-	-

Trial 2

Treatment	Rate (Product % v/v)	Application Timing (% Bloom)
1. ATS	1%	80%
2. ATS	1%	100%
3. ATS	1%	80%+100%
4. ATS	1%	50%+80%+100%
5. Untreated Control	-	-
6. Untreated Control	-	-

Trial 3

Treatment	Rate (Product % v/v)	Application Timing (% Bloom)
1. ATS	1%	80%
2. ATS	1%	100%
3. ATS	1%	80%+100%
4. Hand Thin	-	50 DAFB
5. Untreated Control	-	-

DAFB = days after full bloom

4.2.1.3 Formulations

THIN-IT BLOSSOM THINNER – an aqueous concentrate containing 782 g/L ammonium thiosulphate as marketed by Gro-Chem Limited.

4.2.1.4 Application Method

All treatments were applied using the same equipment, a modified Davidson conventional airblast sprayer, calibrated to deliver 1150 L/ha when travelling at 6.5 km/ha. The spray bar on the unit contained both D2 and D3 nozzles. The bottom jets on either side of the spray bar were turned off leaving 5 nozzles per side targeting the spray into the top portion of the tree canopy.

4.2.1.5 Application Details

Trial	Date	Flower Stage - Top	Temp. ^{o}C	Cloud Cover %	Humidity %	Rainfall +24hrs	Application Volume L/ha
1	29-Aug-07	30-50%	24.7	0	57	0	1159
	02-Sep-07	70-90%	18	0	74	0	1159
2	09-Sep-07	30-50%	24	0	45	0	1159
	12-Sep-07	70-90%	11	0	57	0	1159
	15-Sep-07	100%	11	0	57	0	1159
3	12-Sep-07	80-90%	14	0	58	0	1159
	15-Sep-07	100%	14	0	41	0	1159

4.2.1.6 Experimental Design

Trial Number	Variety	Location	Trial Design	Replicates	Plot Size
1	Tatura 204	Invergordon	RCB	5	5 trees
2	Tatura 211	Invergordon	RCB	5	5 trees
3	Golden Queen	Invergordon	RCB	5	5 trees

4.2.1.7 Assessments

Timing	Assessment
Pre-flowering	Six limbs were tagged in each plot and divided into the top, middle and bottom thirds.
6 weeks after treatment	The total number of fruit remaining on each tagged branch was recorded for each level within the tree canopy. The branch diameter was recorded.
10 days after tip change	100 fruit were sampled from each plot and the total fruit weight recorded.
Commercial harvest	At commercial harvest the total number of fruit and the total fruit weight from each tree was recorded. A sample of fruit from each tree was taken and graded into the size categories as follows: <54 mm, 54-57 mm, 58-60 mm, 61-64 mm, 65-67 mm, 68-70 mm and >70 mm.

4.2.2 2008/2009 Trials

Whilst the airblast equipment was very effective at applying conventional pesticides, spray distribution throughout the full tree profile can be variable. The use of ATS where a low dosage, with small margin for error is required, may not be appropriate through this type of spray equipment. Furness (2005) has developed the Quantum mist sprayer using a multi-head spraying concept which is widely used in viticulture. This concept combines the advantages of providing excellent coverage of even and medium spray particles, where the spray deposit is delivered at a horizontal or near horizontal spray angle and nearer to the target, than from a more vertical angle at greater distances from the target as with conventional airblast equipment. Further, a conventional airblast unit generally delivers a broader range of spray droplet sizes than the Quantum mist sprayer. The concept is based on the theory that large volumes of low velocity air, direct blast, with no ducting or bending of the airstreams, gives the best coverage.

Small plot field trials were established to confirm the efficacy of multiple spray applications and to compare the two spray unit options.

4.2.2.1 Site Details

Trial Number	Variety	Location	Tree Age	Planting Configuration	Training Method	Tree Size
1	Tatura 204	Ardmona	7 years	3.0 m x 5.5 m	Open centre vase	3-4 metres
2	Tatura 204	Invergordon	8 years	5.8 m x 4.0 m	Open centre vase	4 metres
3	Tatura 211	Cobram	5 years	4.0 m x 6.1 m	Open centre vase	4 metres
4	Tatura 211	Ardmona	5 years	2.0 m x 4.8 m	Tatura trellis	3 metres
5	Tatura 211	Ardmona	5 years	2.0 m x 4.8 m	Tatura trellis	3 metres
6	Golden Queen	Cobram	8 years	6.1 m x 6.1 m	Open centre vase	4-5 metres
7	Golden Queen	Invergordon	9 years	3.0 m x 6.1 m	Open vase	3-4 metres

4.2.2.2 Treatments

Trial 1

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1%	30-40%+50-80% FB	1000 L/ha	Airblast
2. ATS	1%	30-40% FB	1000 L/ha	Airblast
3. ATS	1%	50-80% FB	1000 L/ha	Airblast
4. ATS	1%	30-40%+50-80% FB	500 L/ha	Airblast
5. RALEX	2 L/ha	January 2008 (Bud Initiation)	2000 L/ha	Airblast
6. Untreated Control	-	-	-	-

Trial 2

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1%	30-40%+50-80% FB	1000 L/ha	Airblast
2. ATS	1%	30-40% FB	1000 L/ha	Airblast
3. ATS	1%	50-80% FB	1000 L/ha	Airblast
4. ATS	1%	30-40%+50-80% FB	500 L/ha	Airblast
5. Untreated Control	-	-	-	-

Trial 3

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1%	30-40%+50-80% FB	1000 L/ha	Airblast
2. ATS	1%	30-40% FB	1000 L/ha	Airblast
3. ATS	1%	50-80% FB	1000 L/ha	Airblast
4. ATS	1%	30-40%+50-80% FB	1000 L/ha	Quantum mist
5. ATS	1%	50-80% FB	500 L/ha	Quantum mist
6. Untreated Control	-	-	-	-

Trial 4

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1%	30-40%+50-80% FB	800 L/ha	Airblast
2. ATS	1%	30-40% FB	800 L/ha	Airblast
3. ATS	1%	50-80% FB	800 L/ha	Airblast
4. ATS	1%	30-40%+50-80% FB	500 L/ha	Quantum mist
5. Untreated Control	-	-	-	-

Trial 5

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1%	30-40% + 50-80% FB	1000 L/ha	Airblast
2. ATS	1%	30-40% + 50-80% FB	500 L/ha	Airblast
3. ATS	1%	30-40% + 50-80% FB	1000 L/ha	Quantum mist
4. ATS	1%	30-40% + 50-80% FB	500 L/ha	Quantum mist
5. Mechanical thinner	-	-	-	-
6. Untreated Control	-	-	-	-

Trial 5 was abandoned due to uneven irrigation with one row resulting in poor fruit development.

Trial 6

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1%	30-60%+90-100% FB	1000 L/ha	Airblast
2. ATS	1%	30-60% FB	1000 L/ha	Airblast
3. ATS	1%	90-1000% FB	1000 L/ha	Airblast
4. ATS	1%	30-60%+90-100% FB	500 L/ha 500-1000	Quantum Mist
5. RALEX	2 L/ha	January 2008	2000 L/ha	Airblast
6. Untreated Control	-	-	-	-

Trial 7

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1%	40-60%+80-100%	1000 L/ha	Airblast
2. ATS	1%	80-100%	1000 L/ha	Airblast
3. ATS	1%	40-60%+80-100%	1000 L/ha	Quantum mist
4. ATS	1%	40-60%+80-100%	500 L/ha	Quantum mist
5. Untreated Control	-	-	-	-

4.2.2.3 Formulations

THIN-IT BLOSSOM THINNER – an aqueous concentrate containing 782 g/L ammonium thiosulphate as marketed by Gro-Chem Limited.

4.2.2.4 Application Method

Two application methods were used:

Conventional Airblast Sprayer – The equipment used was that of the cooperating grower in each situation. Each sprayer was calibrated to deliver 1000 or 500 L/ha. The bottom jets on either side of the spray bar were turned off leaving the upper nozzles on each side targeting the spray into the top portion of the tree canopy. Application volume was then modified by regulating ground speed.

Quantum Mist Sprayer – A Quantum mist sprayer was purpose built for this project. Incorporating three SARDI fans on a single tower, the unit delivered a more uniform droplet size than a conventional airblast sprayer. The direction of the spray projection was more horizontal and was delivered from nearer the target than through a conventional sprayer. The SARDI fan incorporated TX 18 nozzles and operated at a working pressure of 2000 kPa. Final application volume was determined by ground speed.

4.2.2.5 Application Details

Trial Number	Date	Flower Stage - Top	Temp ^{o}C	Cloud Cover %	Humidity %	Rainfall + 24hrs	Application Volume L/ha
1	25-Aug-08	30-50%	16	30	54	0	1050/525
	30-Aug-08	70-90%	18	60	54	10 mm	1050/525
2	24-Aug-08	20-40%	17	80	50	0	1143
	29-Aug-08	60-80%	18	0	47	0	1050/525
3	14-Sep-08	20-30%	18	0	46	0	AB 925 QM 500-1000
	17-Sep-08	50-80%	16	0	45	0	AB 925 QM 500-1000
4 and 5	14-Sep-08	20-40%	18	40	36	0	1000-500
	18-Sep-08	60-90%	23	0	47	0	1000-500
6	13-Sep-08	30-60%	26	0	38	0	500-1000
	17-Sep-08	90-100%	27	0	40	0	500-1000
7	16-Sep-08	40-60%	18	0	47	0	AB 1149 QM 500-1000
	18-Sep-08	80-100%	29	0	28	0	AB 1149 QM 500-1000

4.2.2.6 Experimental Design

Trial Number	Variety	Location	Trial Design	Replicates	Plot Size
1	Tatura 204	Ardmona	RCB	4	5 trees
2	Tatura 204	Invergordon	RCB	4	5 trees
3	Tatura 211	Cobram	RCB	4	5 trees
4	Tatura 211	Ardmona	RCB	4	8 trees
5	Tatura 211	Ardmona	RCB	4	8 trees
6	Golden Queen	Cobram	RCB	4	5 trees
7	Golden Queen	Invergordon	RCB	4	5 trees

4.2.2.7 Assessments

Timing	Assessment
Pre-flowering	Nine limbs were tagged in each plot and divided into the top, middle and bottom thirds. Then one sub branch was tagged and the number of flowers on that branch recorded.
6 weeks after treatment	The total number of fruit remaining on each tagged branch was recorded for each level within the tree canopy.
10 days after tip change	100 fruit were sampled from each plot and the total fruit weight recorded.
Commercial harvest	At commercial harvest 50 fruit were harvested from each of three trees in each plot and weighed. Fruit was then graded into four size categories as follows: <57 mm, 58-60 mm, 61-63 mm and > 63 mm

4.2.3 2009/2010 Trials

In 2008/2009 single applications were generally not as effective as multiple applications and a program of treatments was considered the appropriate method to follow. The issue of conventional vs Quantum mist was further evaluated. Studies were established to evaluate and compare the two application methods and further confirm efficacy when applied in large scale experiments.

Photo 1: Quantum Mist Sprayer

Photos 2 and 3: Airblast vs Quantum Mist Sprayer in Operation

4.2.3.1 Site Details

Trial Number	Variety	Location	Tree Age	Planting Configuration	Training Method	Tree Size
1	Tatura 204	Ardmona	8 years	2.0 m x 4.25 m	Central leader	4-5 metres
2	Tatura 211	Cobram	8 years	6.1 m x 6.1 m	Open centre vase	3-4 metres
3	Golden Queen	Invergordon	8 years	4.0 m x 5.8 m	Open centre vase	3-4 metres

4.2.3.2 Treatments

Trial 1

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. Mechanical thinner				
2. ATS	1%	30-60% + 50-90% FB	1000 L/ha	Quantum Mist
3. ATS	1%	30-60% + 50-90% FB	1000 L/ha	Airblast
4. Untreated Control	-	-	-	-

Trial 2

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1%	30-60% FB	1000 L/ha	Quantum Mist
2. ATS	1%	30-60% FB	1000 L/ha	Airblast
3. Untreated Control	-	-	-	-

Trial 3

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1%	40-60% + 100% FB	1000 L/ha	Quantum Mist
2. ATS	1%	40-60% + 100% FB	1000 L/ha	Airblast
3. Untreated Control	-	-	-	-

4.2.3.3 Formulation

THIN-IT BLOSSOM THINNER – an aqueous concentrate containing 782 g/L ammonium thiosulphate as marketed by Gro-Chem Limited.

4.2.3.4 Application Method

Two application methods were used:

Conventional Airblast Sprayer – The equipment used was that of the cooperating grower in each situation. Each sprayer was calibrated to deliver 1000 L/ha. The bottom jets on either side of the spray bar were turned off leaving the upper nozzles on each side targeting the spray into the top portion of the tree canopy. Application volume was then modified by regulating ground speed.

Quantum Mist Sprayer – A Quantum mist sprayer was purpose built for this project. Incorporating three SARDI fans on a single tower, the unit delivered a more uniform droplet size than a conventional airblast sprayer. The direction of the spray projection was more horizontal and was delivered from nearer the target than through a conventional sprayer. The SARDI fan incorporated TX 18 nozzles and operated at a working pressure of 2000 kPa. Final application volume was determined by ground speed.

4.2.3.5 Application Details

Trial Number	Date	Flower Stage – Top	Temp °C	Cloud Cover %	Humidity %	Rainfall + 24hrs	Application Volume L/ha
1	22-Aug-09	30-60%	13	100	63	3	AB 950 QM 1000
	27-Aug-09	50-90%	13	0	58	0	AB 950 QM 1000
2	5-Sep-09	30-60%	15	90	77	0	AB 1149 QM-1000
3	9-Sep-09	40-60%	17	0	41	0	AB 1149 QM-1000
	13-Sep-09	100%	19	100	48	0	AB 1149 QM-1000

4.2.3.6 Experimental Design

Trial Number	Variety	Location	Trial Design	Replicates	Block Size
1	Tatura 204	Ardmona	Large block unrandomised	12 internal replicates	0.1 ha
2	Tatura 211	Cobram	Large block unrandomised	12 internal replicates	0.4 ha
3	Golden Queen	Invergordon	Large block unrandomised	12 internal replicates	0.4 ha

4.2.3.7 Assessments

Timing	Assessment
Pre-flowering	Three limbs were tagged on each of 12 trees in each block and divided into the top, middle and bottom thirds. Then one sub branch was tagged and the number of flowers on that branch recorded.
6 weeks after treatment	The total number of fruit remaining on each tagged branch was recorded for each level within the tree canopy.
10 days after tip change	100 fruit were sampled from each plot and the total fruit weight recorded.
Commercial harvest	At commercial harvest 50 fruit were harvested from each of three trees in each plot and weighed. Fruit was then graded into four size categories as follows: <57 mm, 58-60 mm, 65-71 mm, 71-75 mm and > 75 mm

4.2.4 2010/2011 Trials

In 2011 studies were again established to attempt to better understand application through the Quantum mist sprayer and what can be achieved when application timing is correct. Since most thinning is targeted at the top of the tree and the application timing was based upon the flowering in this section of the tree, the sprayer was further adjusted prior to the start of the season. The bottom fan on the sprayer was removed, effectively reducing the output by 30%, targeting only the top 2/3 of the tree.

The choice of the application rate of 1% v/v was accurate for Tatura 211 and Golden Queen. However despite good efficacy being seen on Tatura 204 in year 1, subsequent trials conducted in years 2 and 3 (at slightly lower volumes) did not confirm this. In 2008 the flowering period was very protracted (continuing for almost 2 weeks) and it was thought that insufficient flowers were susceptible at each of the application dates for effective thinning to have been completed. However similar poor performance in Tatura 204 in 2009 confirmed the suspicion that an application rate of 1% may have been too low. The issue of rate was addressed in a Tatura 204 study, and the relative safety of using a higher rate in Tatura 211 and Golden Queen evaluated. Double applications were completed in Tatura 204 and one Golden Queen study only. Adverse weather conditions and machinery breakdowns impacted upon the capability to apply treatments at the optimum timings but did reflect commercial reality.

4.2.4.1 Site Details

Trial Number	Variety	Location	Tree Age	Planting Configuration	Training Method	Tree Size
1	Tatura 204	Cobram 'Block 1'	14 years	6.1 m x 6.1 m	Central leader	4-5 metres
2	Tatura 211	Cobram 'Block 6B'	13 years	6.1 m x 6.1 m	Open centre vase	3-4 metres
3	Tatura 211	Cobram 'Block 14B'	10 years	6.1 m x 6.1 m	Open centre vase	3 metres
4	Golden Queen	Cobram 'Block 12B'	14 Years	6.1 m x 6.1 m	Open centre vase	3-4 metres
5	Golden Queen	Cobram 'Block 29B'	19 years	6.1 m x 6.1 m	Open centre vase	3-4 metres

4.2.4.2 Treatments

Trial 1 and 5

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1.0%	30-50% + 95% FB	700 L/ha	Quantum mist
2. ATS	1.5%	30-50% + 95% FB	700 L/ha	Quantum mist
3. Untreated Control	-	-	-	-

Trials 2, 3 and 4

Treatment	Rate (Product % v/v)	Application Timing	Application Volume	Application Equipment
1. ATS	1.0%	30-60%	700 L/ha	Quantum mist
2. ATS	1.5%	30-60%	700 L/ha	Quantum mist
3. Untreated Control	-	-	-	-

4.2.4.3 Formulations

THIN-IT BLOSSOM THINNER – an aqueous concentrate containing 782 g/L ammonium thiosulphate as marketed by Gro-Chem Limited.

4.2.4.4 Application Method

The Quantum mist sprayer only was used in these studies. In 2010 only the top two fans on the tower were used to target the top 2/3 of the tree. The SARDI fan incorporated TX 18 nozzles and operated at a working pressure of 2000 kPa. Final application volume was determined by ground speed.

4.2.4.5 Application Details

Trial Number	Date	Flower Stage – Top	Temp ^{o}C	Cloud Cover	Humidity	Rainfall + 24hrs	Application Volume
1	31-Sep-10	20-40%	10	100	58	1	700 L/ha
	06-Sep-10	80-100%	15	20	43	0	700 L/ha
2	14-Sep-10	40-70%	Not Recorded	Not Recorded	Not Recorded	8	700 L/ha
3	14-Sep-10	40-70%	Not Recorded	Not Recorded	Not Recorded	8	700 L/ha
4	14-Sep-10	30-70%	Not Recorded	Not Recorded	Not Recorded	8	700 L/ha
5	14-Sep-10	30-70%	Not Recorded	Not Recorded	Not Recorded	8	700 L/ha
	16-Sep-10	50-90%	Not Recorded	Not Recorded	Not Recorded	0	700 L/ha

4.2.4.6 Experimental Design

Trial Number	Location	Variety	Trial Design	Replicates	Block Size
1	Cobram	Tatura 204	Large block unrandomised	9 internal replicates	0.4 ha
2	Cobram	Tatura 211	Large block unrandomised	9 internal replicates	0.7 ha
3	Cobram	Tatura 211	Large block unrandomised	9 internal replicates	0.5 ha
4	Cobram	Golden Queen	Large block unrandomised	9 internal replicates	0.4 ha
5	Cobram	Golden Queen	Large block unrandomised	9 internal replicates	0.3 ha

4.2.4.7 Assessments

Timing	Assessment
Pre-flowering	Three limbs were tagged on each of 9 trees in each block and divided into the top, middle and bottom thirds. Then one sub branch was tagged and the number of flowers on that branch recorded.
6 weeks after treatment	The total number of fruit remaining on each tagged branch was recorded for each level within the tree canopy.
10 days after tip change	100 fruit were sampled from each block and the total fruit weight recorded.
Thinning time	Thinning time was recorded for the Tatura 204 study only
Commercial harvest	At commercial harvest 50 fruit were harvested from each of three trees in each sub plot and weighed. Fruit was then graded into four size categories as follows: <57 mm, 58-60 mm, 61-63 mm and > 63 mm

5. RESULTS

The data presented are summaries of all trials; designed to demonstrate the data trends seen from which the conclusions have been drawn.

These include a summary of the flower mapping work and each of the efficacy studies conducted in both small plot and larger block experiments.

Statistical analyses were conducted using GenStat Release 11.1 (PC/Windows 2008 – Lawes Agricultural Trust, Rothamsted Experimental Station). The model included all treatment effects. Analysis of variance and least significant difference (LSD) procedures were used.

5.1 Project Component 1 – Flower Mapping

Results are summarised in Figures 1-12.

Historical data on flowering times were collected and attempts made to correlate this with winter chill and environmental conditions during the flowering period. However no consistent data were available over multiple seasons to enable an analysis of trends on the impact of the environment on flowering time/duration. Because of this no data on this aspect of the project are presented.

Flower mapping and temperature data for each of the three key cultivars; Tatura 204, Tatura 211 and Golden Queen are presented in Figures 1-3. Flowering data including the variance within blocks are given in Figures 4-12. For analysis purposes flowers were divided into three categories namely – not open or buds closed (considered not susceptible to ATS), open – where the bud flower bud had burst and the reproductive parts were exposed and flowers on which petals were still intact (considered susceptible to ATS), petals fallen – where 2 or more petals had fallen and the pollination process was considered to be complete (considered not susceptible to ATS).

Flowering patterns were not monitored during ensuing years of the project however the flowering duration was.

Figure 1: Percentage of Flowers Open and Daily Temperatures During the Flowering Period for Tatura 204

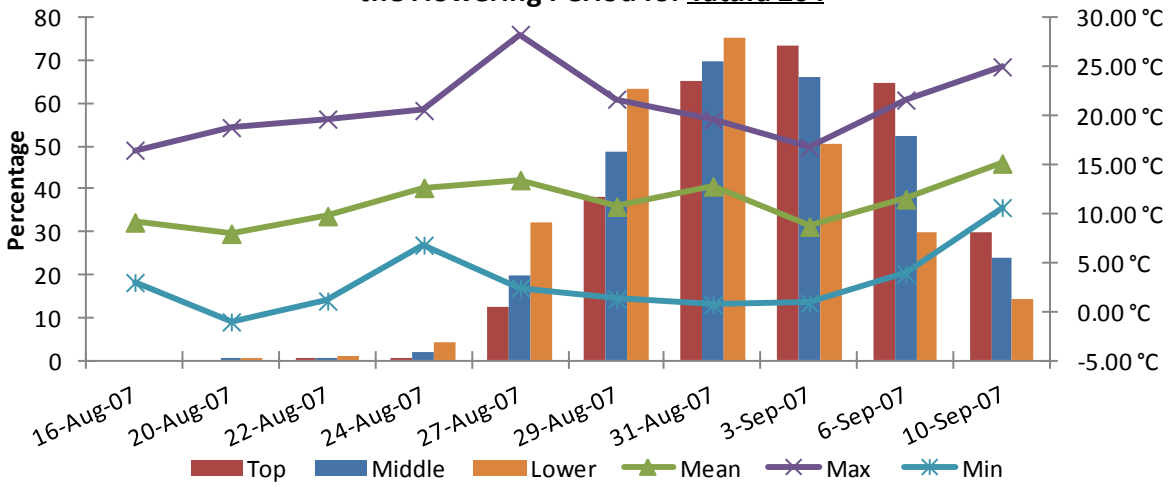


Figure 2: Percentage of Flowers Open and Daily Temperatures During the Flowering Period for Tatura 211

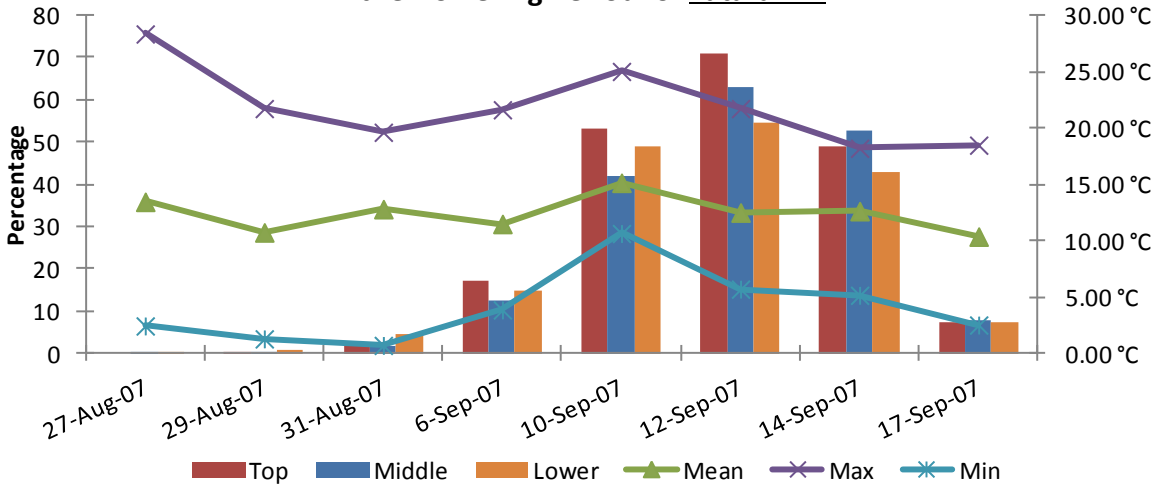


Figure 3: Percentage of Flowers Open and Daily Temperatures During the Flowering Period for Golden Queen

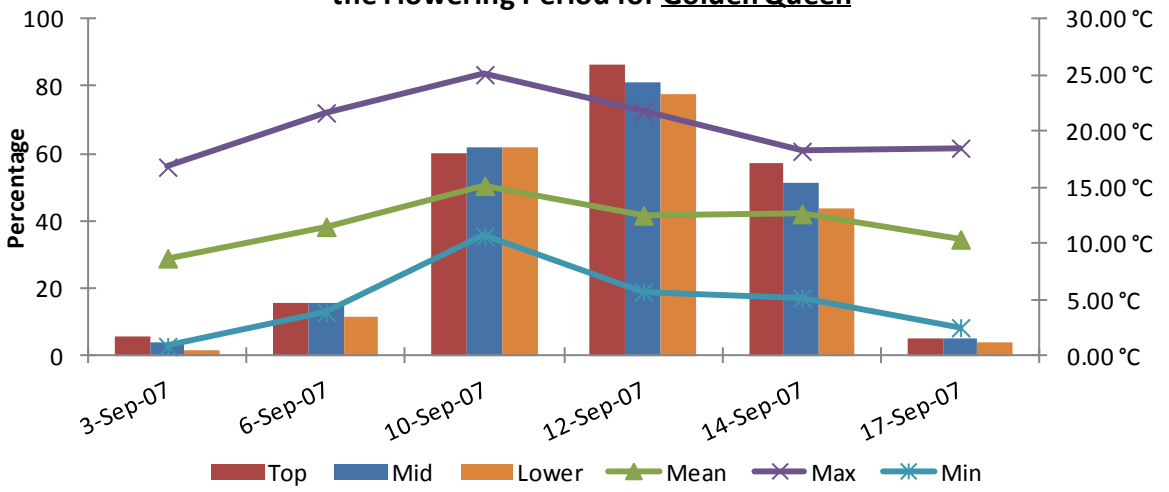


Figure 4: Percentage of Flowers Open and Flowering Variance Within the Block for the Top Sections of the Tree for Tatura 204

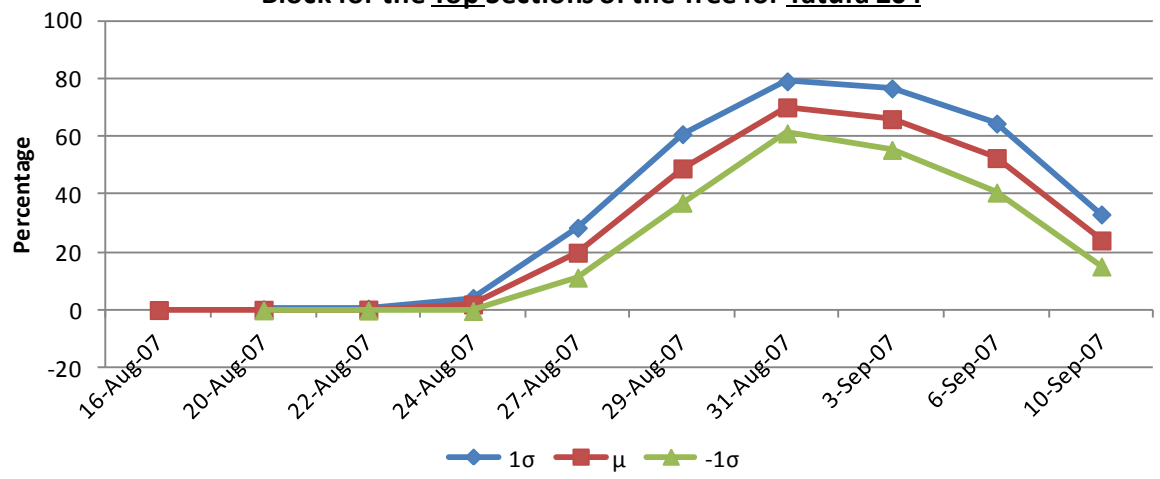


Figure 5: Percentage of Flowers Open and Flowering Variance Within the Block for the Middle Sections of the Tree for Tatura 204

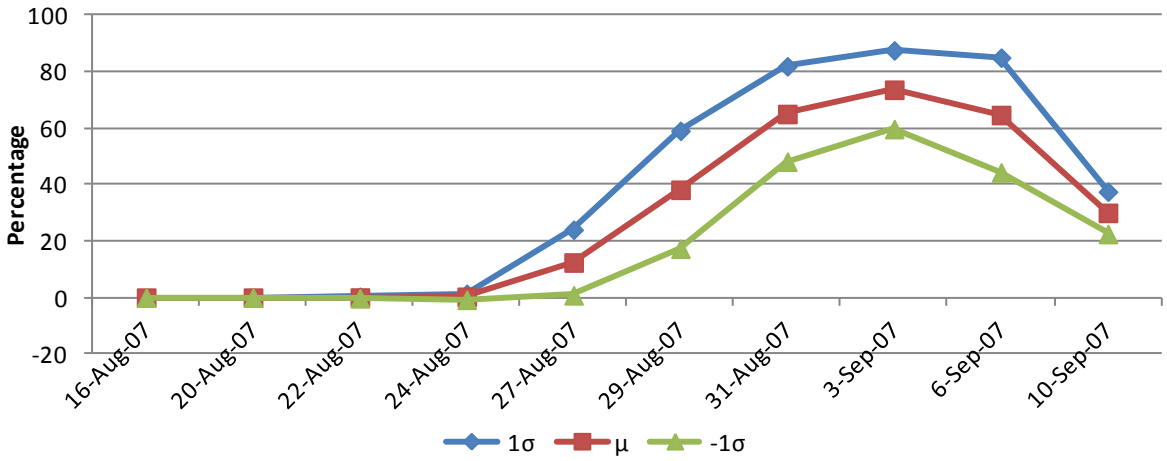


Figure 6: Percentage of Flowers Open and Flowering Variance Within the Block for the Bottom Sections of the Tree for Tatura 204

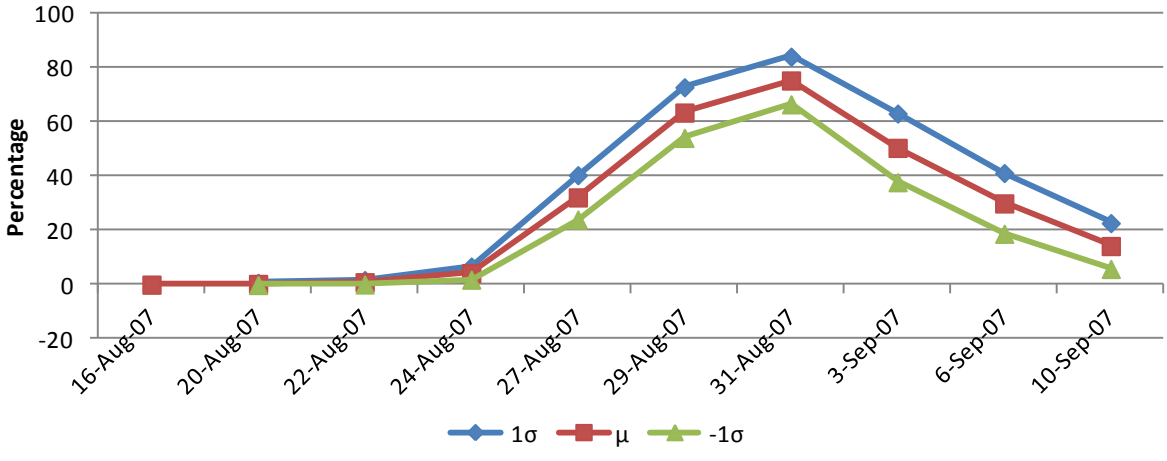


Figure 7: Percentage of Flowers Open and Flowering Variance Within the Block for the Top Sections of the Tree for Tatura 211

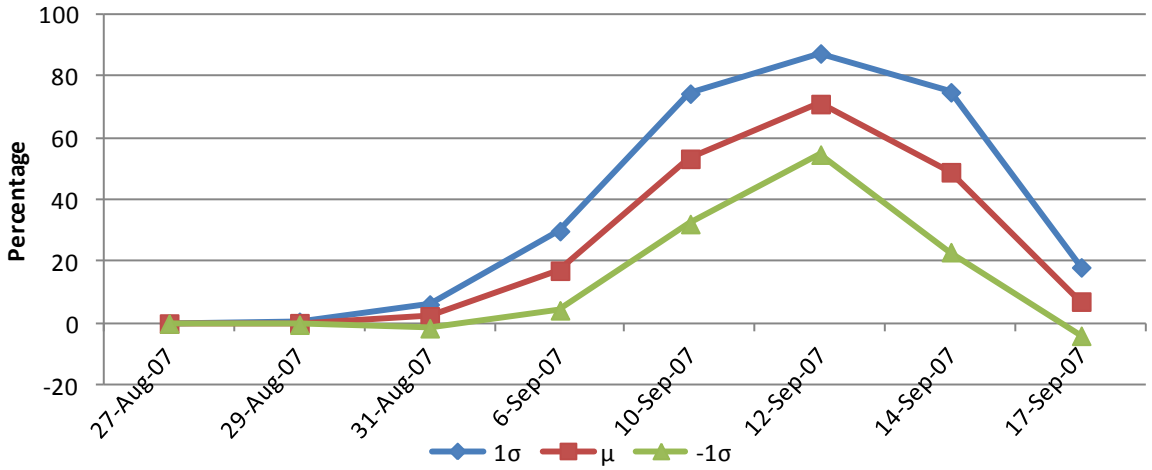


Figure 8: Percentage of Flowers Open and Flowering Variance Within the Block for the Middle Sections of the Tree for Tatura 211

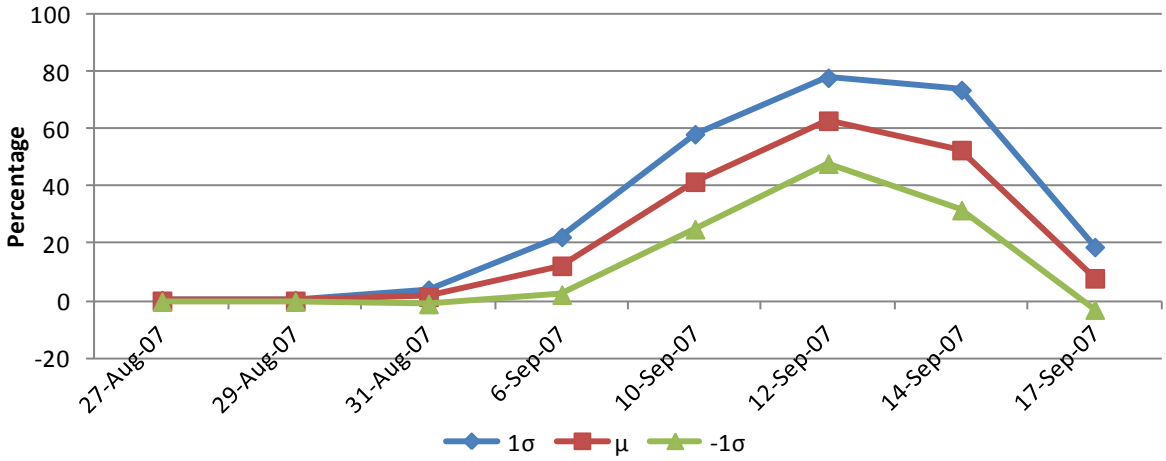


Figure 9: Percentage of Flowers Open and Flowering Variance Within the Block for the Bottom Sections of the Tree for Tatura 211

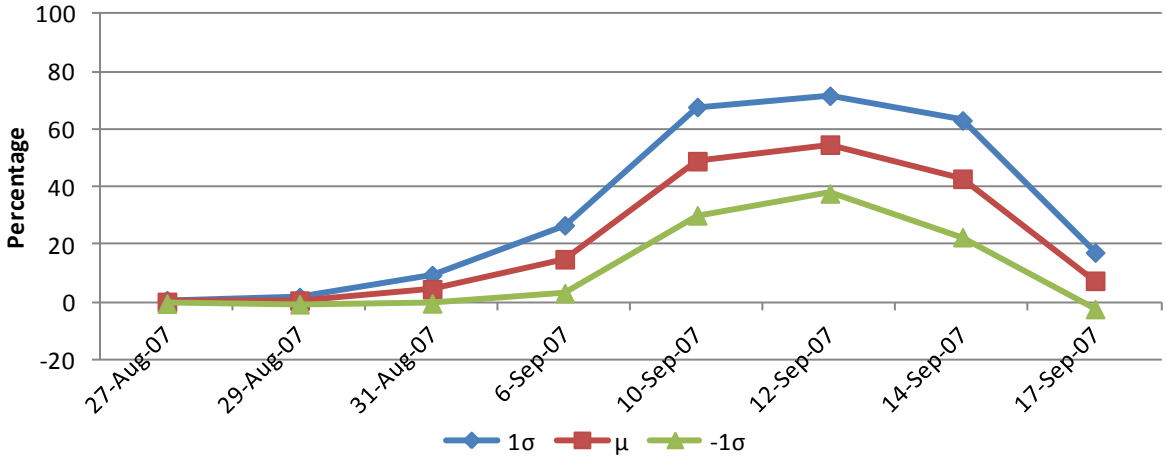


Figure 10: Percentage of Flowers Open and Flowering Variance Within the Block for the Top Sections of the Tree for Golden Queen

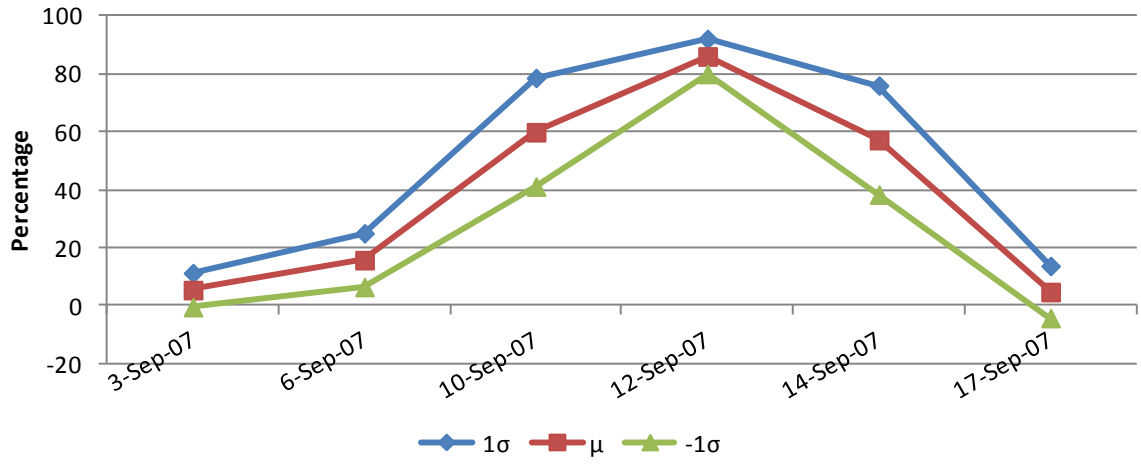


Figure 11: Percentage of Flowers Open and Flowering Variance Within the Block for the Middle Sections of the Tree for Golden Queen

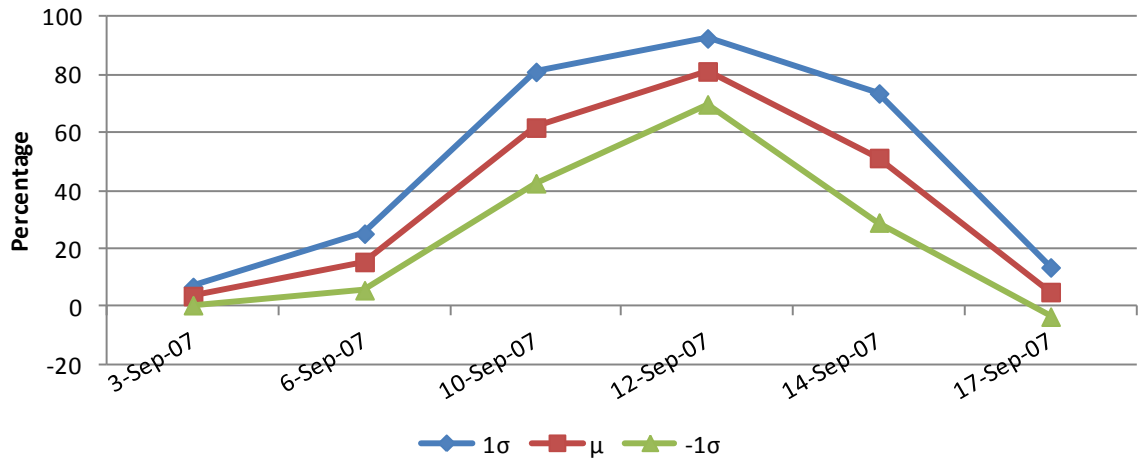
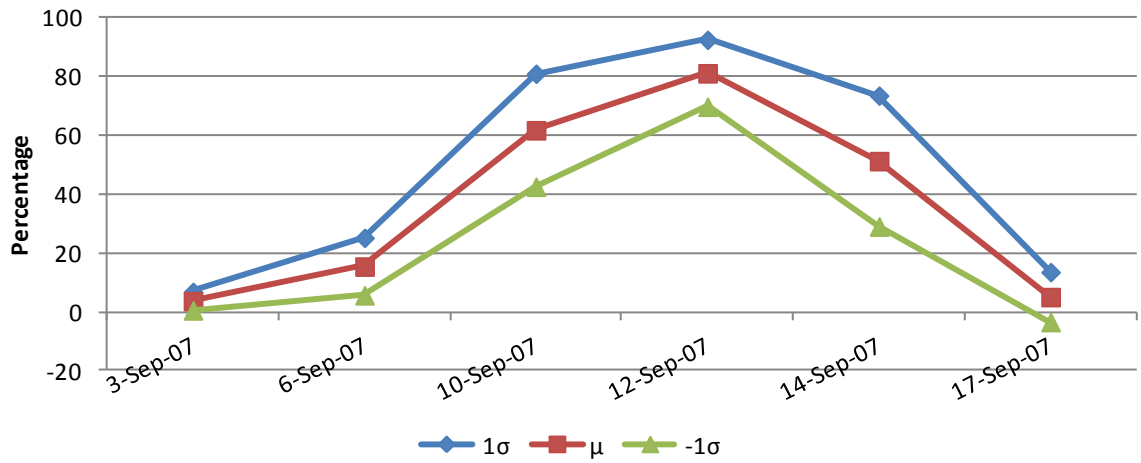


Figure 12: Percentage of Flowers Open and Flowering Variance Within the Block for the Bottom Sections of the Tree for Golden Queen



Data generated from the flower mapping studies determined the following:

- Flowering time (from approximately 10% blooms open to 90% of blooms open) varied between the variety Tatura 204 where flowering occurred over a 2 week period and the varieties Tatura 211 and Golden Queen where flowering occurred over approximately a 1 week period. Mean daily temperatures during the flowering period for each of these varieties were very similar despite flowering occurring at different times.

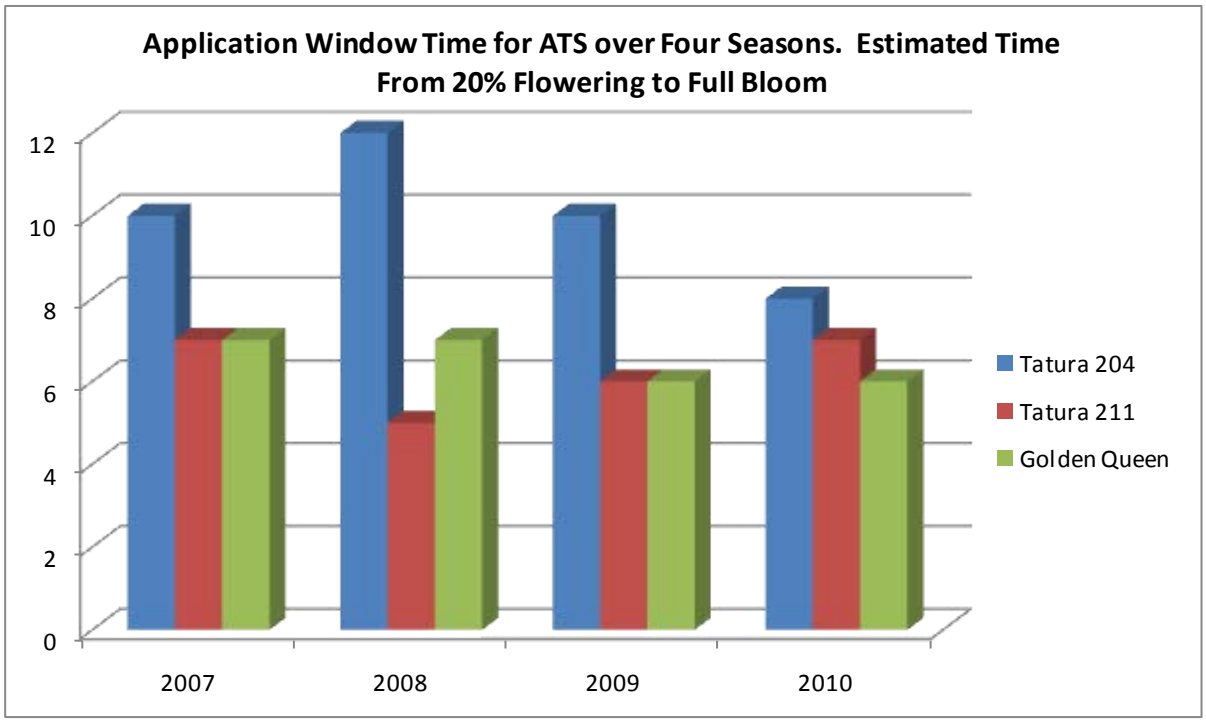
- In Tatura 204 there was a clear pattern of flowering development in a tree with the bottom sections flowering much earlier than the top of the tree. In Tatura 211 and Golden Queen flowering was generally even across the whole tree throughout the flowering period.

- There was a high level of variance in the flowering stage between trees of between 10% and 20% with the lower variance seen in Tatura 204 and the highest in the Tatura 211 block. Confirmation of this level of variance, at all levels within the orchard canopy, confirmed the need for accurate assessments of the exact flowering stage to be completed before any thinning operation is initiated.

- At any time during the flowering period not all flowers are susceptible to ATS with a maximum of 60-80% being considered susceptible during the later flowering period of 80-90% full bloom. Thus with the application rate of 1% in a spray volume of 1000-1200 L/ha being considered 'safe and effective'; complete thinning should not occur at any stage during the flowering period.

- Most fruit is grown in the top third of a tree. Recommendations from this report are to monitor the flowering stages in this region to determine application timing. In Tatura 204, the variation in flowering in the vertical plane may effect efficacy over the tree as a whole. In Tatura 211 and Golden Queen, this may not be an issue.

Flowering period varied considerably between seasons, as noted below, with the extreme being in 2008 when very high temperatures resulted in a very short flowering period of around 5 days for Tatura 211, whilst in the same year the flowering period for Tatura 204 was greater than 2 weeks. In other seasons, particularly 2009 and 2010, wet or showery weather interfered with the ability to apply treatments effectively. Variable weather conditions highlight one of the major limitations with using ATS as a blossom thinner. The natural window for application can be narrow and if adverse weather conditions occur this can be even smaller. Under such conditions it may be possible to complete only one application of ATS.


Application Window Time for ATS over Four Seasons. Estimated Time From 20% Flowering to Full Bloom
12
10
8
6
4
2
0
2007
2008
2009
2010
Tatura 204
Tatura 211
Golden Queen

5.2 Project Component 2 – Efficacy Studies

5.2.1 2007/2008 Trials

Results for the 2007/2008 efficacy studies are presented in Tables 1-15. They include data on fruit set and yield only. No detailed data for crop safety are given as all treatments were safe to peaches in each trial.

5.2.1.1 Trial 1 – Tatura 204 – Invergordon, Victoria

Table 1 Summary of Results – Trial 1 - Tatura 204 - Invergordon, Victoria Mean Number of Fruit per Limb (13-Nov-07)

Treatment	Rate % v/v	Timing % Bloom	1st Limb Upper	1st Limb Lower	1st Limb Total	
1. ATS	1%	70-90%	75.0 a	57.0 a	132.0 a	
2. ATS	1%	50%+70-90%	52.4 a	44.6 a	97.0 a	
3. Untreated Control	-	-	96.4 a	46.0 a	142.4 a	
F Probability			0.237	0.062	0.409	
LSD 10%			ns	ns	ns	
Treatment	Rate % v/v	Timing % Bloom	2nd Limb Upper	2nd Limb Lower	2nd Limb Total	1st and 2nd Limb Average
1. ATS	1%	70-90%	82.6 ab	47.6 a	130.2 b	65.6 ab
2. ATS	1%	50%+70-90%	44.2 a	39.6 a	83.8 a	45.2 a
3. Untreated Control	-	-	115.8 b	47.0 a	162.8 b	76.3 b
F Probability			0.018	0.858	0.074	0.109
LSD 10%			40.5	ns	47.4	20.58

ns = not significant

Table 2 Summary of Results – Trial 1 - Tatura 204 - Invergordon, Victoria Mean Number of Fruit per Cross-Sectional Area (13-Nov-07)

Treatment	Rate % v/v	Timing % Bloom	Number Fruit per X-Section 13-Nov-07
1. ATS	1%	70-90%	3.5
2. ATS	1%	50%+70-90%	2.9
3. Untreated Control	-	-	3.9
F Probability			0.350
LSD 10%			ns

ns = not significant

Table 3 Summary of Results – Trial 1 - Tatura 204 - Invergordon, Victoria Mean Weight per Fruit (g) (14-Nov-07) and Mean Weight per Tree (kg) at Harvest (18-Jan-08 and 25-Jan-08)

Treatment	Rate % v/v	Timing % Bloom	Weight per Fruit (g) 14-Nov-07	Weight per Tree (kg) 18-Jan-08	Weight per Tree (kg) 25-Jan-08
1. ATS	1%	70-90%	23.1 a	35.5	*45.5* a
2. ATS	1%	50%+70-90%	22.2 a	23.6	*33.0* a
3. Untreated Control	-	-	21.4 a	*30.8*	*21.5* a
4. Untreated Control	-	-	23.3 a	22.3	*20.9* a
F Probability			0.592	0.153	0.103
LSD 10%			ns	ns	ns

Means in *italics* are predicted means after analysis accounting for missing values
ns = not significant

Table 4 Summary of Results – Trial 1 - Tatura 204 - Invergordon, Victoria Mean Number of Fruit Picked per Tree (18-Jan-08 and 25-Jan-08) and per Cross-Sectional Area (06-Jan-08)

Treatment	Rate % v/v	Timing % Bloom	Number Fruit Picked/Tree 18-Jan-08	Number Fruit Picked/Tree 25-Jan-08	Number Fruit per X-Section 06-Jan-08
1. ATS	1%	70-90%	311 a	*439* a	3.2 a
2. ATS	1%	50%+70-90%	*199* a	*304* a	2.6 a
3. Untreated Control	-	-	*273* a	*192* a	2.8 a
F Probability			0.240	0.073	0.343
LSD 10%			ns	ns	ns

Means in *italics* are predicted means after analysis accounting for missing values
ns = not significant

Table 5 Summary of Results – Trial 1 - Tatura 204 - Invergordon, Victoria Mean Percentage Fruit in Each Grade Based On Fruit Diameter (mm) (18-Jan-08)

Treatment	Rate % v/v	Timing % Bloom	<54 mm	54-57 mm	58-60 mm	61-64 mm
1. ATS	1%	70-90%	12.5 a	13.4 a	16.8 a	19.4 a
2. ATS	1%	50%+70-90%	5.6 a	9.3 a	12.9 a	19.1 a
3. Untreated Control	-	-	*7.7* a	*9.4* a	*12.6* a	*27.1* a
4. Untreated Control	-	-	10.6 a	13.1 a	14.2 a	23.0 a
F Probability			0.785	0.901	0.711	0.611
LSD 10%			ns	ns	ns	ns
Treatment	Rate % v/v	Timing % Bloom	65-67 mm	68-70 mm	>70 mm	
1. ATS	1%	70-90%	22.0 a	12.7 a	3.2 a	
2. ATS	1%	50%+70-90%	16.6 a	18.7 a	17.8 a	
3. Untreated Control	-	-	*25.3* a	*14.0* a	*4.0* a	
4. Untreated Control	-	-	17.3 a	12.5 a	9.2 a	
F Probability			0.677	0.586	0.116	
LSD 10%			ns	ns	ns	

Means in *italics* are predicted means after analysis accounting for missing values
ns = not significant

Table 6 Summary of Results – Trial 1 - Tatura 204 - Invergordon, Victoria Mean Percentage Fruit in Each Grade Based On Fruit Diameter (mm) (25-Jan-08)

Treatment	Rate % v/v	Timing % Bloom	<54 mm	54-57 mm	58-60 mm	61-64 mm
1. ATS	1%	70-90%	*9.3* a	*11.7* a	*17.0* b	*21.1* a
2. ATS	1%	50%+70-90%	*8.1* a	*8.8* a	*11.1* a	*19.5* a
3. Untreated Control	-	-	*13.5* a	*11.3* a	*19.1* b	*19.8* a
4. Untreated Control	-	-	9.1 a	11.0 a	9.7 a	20.6 a
F Probability			0.820	0.900	0.036	0.983
LSD 10%			ns	ns	5.23	ns
Treatment	Rate % v/v	Timing % Bloom	65-67 mm	68-70 mm	>70 mm	
1. ATS	1%	70-90%	*15.3* a	*12.5* a	*13.0* a	
2. ATS	1%	50%+70-90%	*13.6* a	*13.9* a	*25.1* b	
3. Untreated Control	-	-	*11.6* a	*13.3* a	*11.5* a	
4. Untreated Control	-	-	13.8 a	18.2 a	17.7 ab	
F Probability			0.733	0.348	0.168	
LSD 10%			ns	ns	10.54	

Means in *italics* are predicted means after analysis accounting for missing values
ns = not significant

5.2.1.2 Trial 2 - Tatura 211 - Invergordon, Victoria

Table 7 Summary of Results – Trial 2 - Tatura 211 - Invergordon, Victoria Mean Number of Fruit per Limb (19-Nov-07)

Treatment	Rate % v/v	Timing % Bloom	Western Limb Upper	Western Limb Lower	Western Limb Total	
1. ATS	1%	80%	70.6 a	43.4	114.0 abc	
2. ATS	1%	100%	57.6 a	36.8	94.4 ab	
3. ATS	1%	80%+100%	55.8 a	33.8	89.6 ab	
4. ATS	1%	50%+80%+100%	59.4 a	29.0	88.4 a	
5. Untreated Control	-	-	109.6 b	51.4	161.0 c	
6. Untreated Control	-	-	82.2 ab	57.4	139.6 bc	
F Probability			0.063	0.329	0.107	
LSD 10%			31.79	ns	50.44	
Treatment	Rate % v/v	Timing % Bloom	Eastern Limb Upper	Eastern Limb Lower	Eastern Limb Total	Western + Eastern Average
1. ATS	1%	80%	61.0	35.4 abc	96.4 abc	105.2 ab
2. ATS	1%	100%	56.4	26.8 ab	83.2 a	88.8 a
3. ATS	1%	80%+100%	57.0	33.8 abc	90.8 ab	90.2 a
4. ATS	1%	50%+80%+100%	56.4	24.2 a	80.6 a	84.5 a
5. Untreated Control	-	-	74.6	48.2 c	122.8 bc	141.9 c
6. Untreated Control	-	-	84.2	44.0 bc	128.2 c	133.9 bc
F Probability			0.284	0.192	0.156	0.061
LSD 10%			ns	17.8	37.3	37.8

ns = not significant

Table 8 Summary of Results – Trial 2 - Tatura 211 - Invergordon, Victoria Mean Number of Fruit per Cross-Sectional Area (13-Nov-2007)

Treatment	Rate % v/v	Timing % Bloom	East Limb	East Limb	Average Limb
1. ATS	1%	80%	3.4 ab	2.5 ab	3.0 ab
2. ATS	1%	100%	2.9 a	2.7 ab	2.8 ab
3. ATS	1%	80%+100%	2.4 a	2.7 ab	2.6 a
4. ATS	1%	50%+80%+100%	2.7 a	2.1 a	2.4 a
5. Untreated Control	-	-	4.2 a	3.3 bc	3.7 bc
6. Untreated Control	-	-	4.5 b	4.0 c	4.3 c
F Probability			0.184	0.093	0.027
LSD 10%			1.58	0.932	0.983

Table 9 Summary of Results – Trial 2 - Tatura 211 - Invergordon, Victoria Mean Weight per Fruit (g) (15-Nov-07 and 12-Feb-08) and Mean Weight per Tree (kg) (12-Feb-08)

Treatment	Rate % v/v	Timing % Bloom	Weight per Fruit (g) 15-Nov-07	Weight per Fruit (g) 12-Feb-08	Weight per Tree (kg) 12-Feb-08
1. ATS	1%	80%	16.0 b	118.7 a	40.1 a
2. ATS	1%	100%	15.9 b	119.1 a	52.8 a
3. ATS	1%	80%+100%	17.2 ab	121.5 a	51.9 a
4. ATS	1%	50%+80%+100%	18.8 a	128.3 a	50.1 a
5. Untreated Control	-	-	16.3 b	116.8 a	67.7 a
6. Untreated Control	-	-	15.7 b	107.7 a	55.4 a
F Probability			0.018	0.487	0.333
LSD 5%			1.8	ns	ns

ns = not significant

Table 10 Summary of Results – Trial 2 - Tatura 211 - Invergordon, Victoria Mean Number of Fruit per Tree (12-Feb-08) and per Cross-Sectional Area (12-Feb-08)

Treatment	Rate % v/v	Timing % Bloom	Number per Tree 12-Feb-08	Number per X-Section 12-Feb-08
1. ATS	1%	80%	345.9 a	2.4 a
2. ATS	1%	100%	437.1 a	2.8 a
3. ATS	1%	80%+100%	452.1 a	3.0 a
4. ATS	1%	50%+80%+100%	421.1 a	2.7 a
5. Untreated Control	-	-	586.6 a	3.7 a
6. Untreated Control	-	-	512.0 a	3.2 a
F Probability			0.120	0.630
LSD 5%			ns	ns

ns = not significant

Table 11 Summary of Results – Trial 2 - Tatura 211 - Invergordon, Victoria Mean Percentage Fruit in Each Grade Based On Fruit Diameter (mm) (12-Feb-08)

Treatment	Rate % v/v	Timing % Bloom	<54 mm	54-57 mm	58-60 mm	61-64 mm
1. ATS	1%	80%	11.0 ab	8.0 a	13.7 a	13.8 a
2. ATS	1%	100%	3.4 a	3.6 a	11.2 a	14.1 a
3. ATS	1%	80%+100%	5.7 a	9.2 a	12.8 a	13.1 a
4. ATS	1%	50%+80%+100%	6.3 a	8.2 a	15.6 a	11.6 a
5. Untreated Control	-	-	4.0 a	7.5 a	17.6 a	15.6 a
6. Untreated Control	-	-	24.7 b	16.8 a	18.8 a	16.6 a
F Probability			0.048	0.324	0.637	0.890
LSD 5%			##	ns	ns	ns
Treatment	Rate % v/v	Timing % Bloom	65-67 mm	68-70 mm	>70 mm	
1. ATS	1%	80%	20.9 a	17.8 a	14.8 ab	
2. ATS	1%	100%	24.9 a	25.2 a	17.6 b	
3. ATS	1%	80%+100%	18.9 a	18.9 a	21.6 b	
4. ATS	1%	50%+80%+100%	12.8 a	19.4 a	26.1 b	
5. Untreated Control	-	-	25.6 a	16.0 a	13.8 b	
6. Untreated Control	-	-	15.6 a	5.1 a	2.3 a	
F Probability			0.442	0.123	0.047	
LSD 5%			ns	ns	#	

ns = not significant
# = LSD's and letters applied to log transformed data
= LSD's and letters applied to square root transformed data

5.2.1.3 Trial 3 - Golden Queen - Invergordon, Victoria

Table 12 Summary of Results – Trial 3 - Golden Queen - Invergordon, Victoria Mean Number of Fruit per Limb (10-Oct-07)

Treatment	Rate % v/v	Timing % Bloom	Western Limb Upper	Western Limb Lower	Western Limb Total	
1. ATS	1%	80%	135.6 a	109.4 a	245.0 a	
2. ATS	1%	100%	120.8 a	47.8 a	168.6 a	
3. ATS	1%	80%+100%	140.0 a	97.4 a	237.4 a	
4. Hand Thin	-	50 DAFB	130.4 a	121.8 a	252.2 a	
5. Untreated Control	-	-	125.8 a	74.2 a	200.0 a	
F Probability			0.964	0.091	0.239	
LSD 5%			ns	ns	ns	
Treatment	Rate % v/v	Timing % Bloom	Eastern Limb Upper	Eastern Limb Lower	Eastern Limb Total	Western + Eastern Average
1. ATS	1%	80%	144.6 a	91.4 a	236.0 a	240.5 a
2. ATS	1%	100%	157.8 a	65.4 a	223.2 a	195.9 a
3. ATS	1%	80%+100%	180.4 a	126.6 a	307.0 a	272.2 a
4. Hand Thin	-	50 DAFB	179.8 a	116.0 a	295.8 a	274.0 a
5. Untreated Control	-	-	156.2 a	134.0 a	290.2 a	245.1 a
F Probability			0.736	0.197	0.289	0.197
LSD 5%			ns	ns	ns	ns

ns = not significant
DAFB = days after full bloom

Table 13 Summary of Results – Trial 3 - Golden Queen - Invergordon, Victoria Mean Weight per Fruit (g) (19-Nov-07 and 03-Mar-08) and Mean Weight per Tree (kg) (11-Mar-08)

Treatment	Rate % v/v	Timing % Bloom	Weight per Fruit (g) 19-Nov-07	Weight per Fruit (g) 03-Mar-08	Weight per Tree (kg) 11-Mar-08
1. ATS	1%	80%	19.3 a	31.6 a	24.7 a
2. ATS	1%	100%	20.3 a	34.8 a	23.0 a
3. ATS	1%	80%+100%	18.8 a	31.4 a	24.6 a
4. Hand Thin	-	50 DAFB	19.2 a	29.9 a	34.2 a
5. Untreated Control	-	-	19.8 a	34.3 a	23.7 a
F Probability			0.723	0.973	0.642
LSD 5%			ns	ns	ns

DAFB = days after full bloom
ns = not significant

Table 14 Summary of Results – Trial 3 - Golden Queen - Invergordon, Victoria Mean Number of Fruit per Tree (03-Mar-08 and 11-Mar-08) and per Cross-Sectional Area (29-Feb-08, 03-Mar-08 and 11-Mar-08)

Treatment	Rate % v/v	Timing % Bloom	Number per Tree 03-Mar-08	Number per Tree 11-Mar-08
1. ATS	1%	80%	216.4 a	183.0 a
2. ATS	1%	100%	203.0 a	161.4 a
3. ATS	1%	80%+100%	202.0 a	171.0 a
4. Hand Thin	-	50 DAFB	208.2 a	250.0 a
5. Untreated Control	-	-	219.2 a	160.2 a
F Probability			0.997	0.595
LSD 5%			ns	ns

Treatment	Rate % v/v	Timing % Bloom	Number per X-Section 29-Feb-08	Number per X-Section 03-Mar-08	Number per X-Section 11-Mar-08
1. ATS	1%	80%	4.0 a	2.2 a	1.9 a
2. ATS	1%	100%	3.5 a	1.9 a	1.5 a
3. ATS	1%	80%+100%	3.7 a	2.3 a	1.8 a
4. Hand Thin	-	50 DAFB	4.2 a	2.1 a	2.5 a
5. Untreated Control	-	-	3.5 a	2.1 a	1.6 a
F Probability			0.888	0.988	0.634
LSD 5%			ns	ns	ns

DAFB = days after full bloom
ns = not significant

Table 15 Summary of Results – Trial 3 - Golden Queen - Invergordon, Victoria Mean Percentage Fruit in Each Grade Based On Fruit Diameter (mm) (13-Mar-08)

Treatment	Rate % v/v	Timing % Bloom	<54 mm	54-57 mm	58-60 mm	61-64 mm
1. ATS	1%	80%	0.8 a	1.2 a	5.0 a	10.2 a
2. ATS	1%	100%	1.8 a	4.2 a	7.8 a	8.6 a
3. ATS	1%	80%+100%	1.2 a	2.0 a	4.2 a	7.7 a
4. Hand Thin	-	50 DAFB	0.6 a	1.2 a	5.2 a	5.6 a
5. Untreated Control	-	-	2.5 a	4.9 a	6.6 a	5.2 a
F Probability			0.357	0.372	0.820	0.491
LSD 5%			ns	ns	ns	ns

Treatment	Rate % v/v	Timing % Bloom	65-67 mm	68-70 mm	>70 mm
1. ATS	1%	80%	22.0 a	25.7 a	35.0 a
2. ATS	1%	100%	19.4 a	23.8 a	34.4 a
3. ATS	1%	80%+100%	19.0 a	24.7 a	41.2 a
4. Hand Thin	-	50 DAFB	18.0 a	25.0 a	44.4 a
5. Untreated Control	-	-	24.8 a	21.8 a	34.2 a
F Probability			0.510	0.648	0.822
LSD 5%			ns	ns	ns

DAFB = days after full bloom
ns = not significant

The reputation of ammonium thiosulphate (ATS) to produce variable efficacy results in stone fruit, was seen in this year. Fruit set counts were not completed following flowering in these trials and total tree fruit counts were therefore done. In Tatura 204 and Tatura 211 significant differences in crop load were seen in tagged limbs prior to hand thinning. These data confirmed that the double application of ATS at around 30-50% FB and near full bloom generally provided better thinning than the single application. A high level of variance was seen in the thinning data in each of these studies which was considered to perhaps reflect differences in flowering development between trees or variable spray application from the airblast unit. Each block was hand thinned evenly at stone hardening and yield data were generally less conclusive, although data trends did show a higher proportion of fruit in the larger size grades for the multiple application ATS treatments.

5.2.2 2008/2009 Trials

Results for the 2008/2009 efficacy studies are presented in Tables 16-33. They include data on fruit set and yield only. No detailed data for crop safety are given as all treatments were safe to peaches in each trial. No data are presented for Trial 5 (Ardmona). Blocked sprinklers in one row in this study resulted in poor tree and fruit growth in this section of the trial rendering any data meaningless.

5.2.2.1 Trial 1 – Tatura 204 – Ardmona

Table 16 Summary of Results – Trial 1 - Tatura 204 - Ardmona, Victoria Mean Percentage Fruit Set (17-Oct-08)

Treatment	Rate % v/v	Timing % Bloom	Application Volume	Application Equipment	Lower	Middle	Top	Overall Fruit Set
1. ATS	1%	30-40%+50-80%	1000 L/ha	Airblast	41.4	60.3	68.1	55.1
2. ATS	1%	30-40%	1000 L/ha	Airblast	43.6	59.6	79.1	61.1
3. ATS	1%	50-80%	1000 L/ha	Airblast	34.7	55.2	78.4	56.7
4. ATS	1%	30-40%+50-80%	500 L/ha	Airblast	40.2	59.2	73.7	58.7
5. RALEX	2 L/ha	January 2008	2000 L/ha	Airblast	*	*	*	*
6. Untreated Control	-	-	-	-	44.2	63.0	88.0	64.4
F Probability					0.894	0.875	0.318	0.631
LSD 5%					ns	ns	ns	ns

ns = not significant
* = Fruit set counts not taken for RALEX

Table 17 Summary of Results – Trial 1 - Tatura 204 - Ardmona, Victoria Mean 100 Fruit Weight (kg) at Stone Hardening (18-Nov-08) and at Harvest (23-Jan-09)

Treatment	Rate % v/v	Timing % Bloom	Application Volume	Application Equipment	100 Fruit Weight 18-Nov-08	100 Fruit Weight 23-Jan-09
1. ATS	1%	30-40%+50-80%	1000 L/ha	Airblast	2.46	14.0
2. ATS	1%	30-40%	1000 L/ha	Airblast	2.57	13.3
3. ATS	1%	50-80%	1000 L/ha	Airblast	2.58	13.4
4. ATS	1%	30-40%+50-80%	500 L/ha	Airblast	2.54	13.4
5. RALEX	2 L/ha	January 2008	2000 L/ha	Airblast	2.84	15.0
6. Untreated Control	-	-	-	-	2.64	13.7
F Probability					0.183	0.406
LSD 5%					ns	ns

ns = not significant

Table 18 Summary of Results – Trial 1 - Tatura 204 - Ardmona, Victoria Mean Fruit Size Distribution at Harvest (23-Jan-09)

Treatment	Rate % v/v	Timing % Bloom	Application Volume	Application Equipment	<57 mm	58-60 mm	61-63 mm	>63 mm
1. ATS	1%	30-40%+50-80%	1000 L/ha	Airblast	7.8	14.7	24.3 ab	53.2
2. ATS	1%	30-40%	1000 L/ha	Airblast	15.1	14.4	24.0 ab	46.5
3. ATS	1%	50-80%	1000 L/ha	Airblast	11.5	12.9	29.6 a	46.1
4. ATS	1%	30-40%+50-80%	500 L/ha	Airblast	10.8	13.5	21.0 b	54.7
5. RALEX	2 L/ha	January 2008	2000 L/ha	Airblast	5.5	7.5	19.0 b	68.1
6. Untreated Control	-	-	-	-	11.2	15.8	22.3 b	50.7
F Probability					0.562	0.380	0.046	0.340
LSD 5%					ns	ns	6.3	ns

ns = not significant

5.2.2.2 Trial 2 – Tatura 204 – Invergordon

Table 19 Summary of Results – Trial 2 - Tatura 204 - Invergordon, Victoria Mean Percentage Fruit Set (17-Oct-08)

Treatment	Rate % v/v	Timing % Bloom	Application Volume	Application Equipment	Lower	Middle	Top	Overall Fruit Set
1. ATS	1%	30-40%+50-80%	1000 L/ha	Airblast	28.8	43.3	49.7	40.6
2. ATS	1%	30-40%	1000 L/ha	Airblast	32.7	36.2	54.5	41.1
3. ATS	1%	50-80%	1000 L/ha	Airblast	35.3	46.2	53.5	45.0
4. ATS	1%	30-40%+50-80%	500 L/ha	Airblast	28.4	43.4	44.5	38.8
5. Untreated Control	-	-	-	-	27.5	42.6	58.9	43.0
F Probability					0.650	0.521	0.055	0.650
LSD 5%					ns	ns	ns	ns

ns = not significant

Table 20 Summary of Results – Trial 2 - Tatura 204 - Invergordon, Victoria Mean 100 Fruit Weight (kg) at Stone Hardening (19-Nov-08) and at Harvest (22-Jan-09)

Treatment	Rate % v/v	Timing % Bloom	Application Volume	Application Equipment	100 Fruit Weight 19-Nov-08	100 Fruit Weight 22-Jan-09
1. ATS	1%	30-40%+50-80%	1000 L/ha	Airblast	2.4	11.0
2. ATS	1%	30-40%	1000 L/ha	Airblast	2.4	10.9
3. ATS	1%	50-80%	1000 L/ha	Airblast	2.2	9.7
4. ATS	1%	30-40%+50-80%	500 L/ha	Airblast	2.3	11.4
5. Untreated Control	-	-	-	-	2.3	10.7
F Probability					0.486	0.529
LSD 5%					ns	ns

ns = not significant

Table 21 Summary of Results – Trial 2 - Tatura 204 - Invergordon, Victoria Mean Fruit Size Distribution at Harvest (23-Jan-09)

Treatment	Rate % v/v	Timing % Bloom	Application Volume	Application Equipment	<57 mm	58-60 mm	61-63 mm	>63 mm
1. ATS	1%	30-40%+50-80%	1000 L/ha	Airblast	38.6	22.2	20.4	18.8
2. ATS	1%	30-40%	1000 L/ha	Airblast	35.2	24.4	23.0	17.4
3. ATS	1%	50-80%	1000 L/ha	Airblast	61.4	21.8	9.9	6.8
4. ATS	1%	30-40%+50-80%	500 L/ha	Airblast	49.6	22.4	17.9	10.0
5. Untreated Control	-	-	-	-	40.7	28.2	18.5	12.6
F Probability					0.099	0.652	0.118	0.379
LSD 5%					ns	ns	ns	ns

ns = not significant

5.2.2.3 Trial 3 – Tatura 211 – Cobram

Table 22 Summary of Results – Trial 3 - Tatura 211 - Cobram, Victoria Mean Percentage Fruit Set (3-Nov-08)

Treatment	Rate % v/v	Timing % Bloom	Application Equipment	Application Volume	Lower	Middle	Top	Overall Fruit Set
1. ATS	1%	30-40%+50-80%	Airblast	1000 L	55.5 abc	66.0	60.8	60.7 ab
2. ATS	1%	30-40%	Airblast	1000 L	61.2 bc	65.7	57.3	61.4 ab
3. ATS	1%	50-80%	Airblast	1000 L	69.3 abc	70.1	62.8	67.4 b
4. ATS	1%	30-40%+50-80%	Quantum Mist	1000 L	50.2 a	61.0	65.1	58.8 a
5. ATS	1%	50-80%	Quantum Mist	500 L	61.8 bc	71.0	62.7	65.2 ab
6. Untreated Control	-	-	-	-	64.2 c	70.5	64.4	66.4 ab
F Probability					0.796	0.614	0.120	0.130
LSD 10%					10.250	ns	ns	8.300

ns = not significant

Table 23 Summary of Results – Trial 3 - Tatura 211 - Cobram, Victoria Mean 100 Fruit Weight (kg) at Stone Hardening (10-Nov-08) and Harvest (20-Feb-09)

Treatment	Rate % v/v	Timing % Bloom	Application Equipment	Application Volume	100 Fruit Weight 10-Nov-08	100 Fruit Weight 20-Feb-09
1. ATS	1%	30-40%+50-80%	Airblast	1000 L	1.319 ab	9.62 ab
2. ATS	1%	30-40%	Airblast	1000 L	1.290 b	8.87 c
3. ATS	1%	50-80%	Airblast	1000 L	1.263 bc	9.96 a
4. ATS	1%	30-40%+50-80%	Quantum Mist	1000 L	1.390 a	10.14 a
5. ATS	1%	50-80%	Quantum Mist	500 L	1.348 ab	9.87 a
6. Untreated Control	-	-	-	-	1.190 c	9.03 bc
F Probability					0.003	0.051
LSD 10%					0.0989	0.760

Table 24 Summary of Results – Trial 3 - Tatura 211 - Cobram, Victoria Mean Fruit Size Distribution at Harvest (20-Feb-09)

Treatment	Rate % v/v	Timing % Bloom	Application Equipment	Application Volume	<57 mm	58-60 mm	61-63 mm	>63 mm
1. ATS	1%	30-40%+50-80%	Airblast	1000 L	58.5 abc	25.0 abc	14.0 abc	2.5
2. ATS	1%	30-40%	Airblast	1000 L	69.9 a	22.4 c	6.2 d	1.6
3. ATS	1%	50-80%	Airblast	1000 L	47.8 c	32.3 a	17.6 ab	2.3
4. ATS	1%	30-40%+50-80%	Quantum Mist	1000 L	42.8 c	32.7 a	20.4 a	4.2
5. ATS	1%	50-80%	Quantum Mist	500 L	52.5 bc	31.9 ab	12.0 bcd	3.6
6. Untreated Control	-	-	-	-	66.3 ab	24.5 bc	8.3 cd	0.9
F Probability					0.020	0.032	0.011	0.375
LSD 5%					16.4	7.7	7.7	ns

ns = not significant

5.2.2.4 Trial 4 – Tatura 211 – Ardmona

Table 25 Summary of Results – Trial 4 - Tatura 211 - Ardmona, Victoria Mean Percentage Fruit Set (5-Nov-08)

Treatment	Rate % v/v	Timing % Bloom	Application Equipment	Application Volume	Lower	Middle	Top	Overall Fruit Set
1. ATS	1%	30-40%+50-80%	Airblast	800 L	44.1 a	67.1	45.4 a	52.2 a
2. ATS	1%	30-40%	Airblast	800 L	61.9 b	64.2	55.1 ab	60.4 bc
3. ATS	1%	50-80%	Airblast	800 L	72.9 b	58.3	61.3 b	64.2 cd
4. ATS	1%	30-40%+50-80%	Quantum Mist	500 L	44.3 a	69.2	53.6 ab	55.7 ab
5. Untreated Control	-	-	-	-	71.0 b	71.6	62.0 b	68.2 d
F Probability					0.10	0.98	0.09	0.039
LSD 10%					12.2	ns	9.7	5.9

ns = not significant

Table 26 Summary of Results – Trial 4 - Tatura 211 - Ardmona, Victoria Mean 100 Fruit Weight (kg) at Stone Hardening (10-Nov-08) and Harvest (20-Feb-09)

Treatment	Rate % v/v	Timing % Bloom	Application Equipment	Application Volume	100 Fruit Weight 10-Nov-08	100 Fruit Weight 20-Feb-09
1. ATS	1%	30-40%+50-80%	Airblast	800 L	1.53	9.09
2. ATS	1%	30-40%	Airblast	800 L	1.63	8.68
3. ATS	1%	50-80%	Airblast	800 L	1.50	9.25
4. ATS	1%	30-40%+50-80%	Quantum Mist	500 L	1.49	9.27
5. Untreated Control	-	-	-	-	1.44	8.46
F Probability					0314	0.407
LSD 5%					ns	ns

ns = not significant

Table 27 Summary of Results – Trial 4 - Tatura 211 - Ardmona, Victoria Mean Fruit Size Distribution at Harvest (20-Feb-09)

Treatment	Rate % v/v	Timing % Bloom	Application Equipment	Application Volume	<57 mm	58-60 mm	61-63 mm	>63 mm
1. ATS	1%	30-40%+50-80%	Airblast	800 L	72.8	20.0 ab	5.8	1.5
2. ATS	1%	30-40%	Airblast	800 L	73.2	20.9 ab	4.8	1.1
3. ATS	1%	50-80%	Airblast	800 L	68.0	23.6 a	6.1	2.3
4. ATS	1%	30-40%+50-80%	Quantum Mist	500 L	64.1	24.0 a	9.4	2.5
5. Untreated Control	-	-	-	-	82.5	11.1 b	4.4	2.0
F Probability					0.381	0.090	0.741	0.957
LSD 5%					ns	9.93	ns	ns

ns – not significant

5.2.2.5 Trial 6 – Golden Queen – Cobram

Table 28 Summary of Results – Trial 6 - Golden Queen - Cobram Victoria Mean Percentage Fruit Set (05-Nov-08)

Treatment	Rate % v/v	Timing % Bloom	Application Equipment	Application Volume	Lower	Middle	Top	Overall Fruit Set
1. ATS	1%	30-60%+90-100%	Airblast	1000 L	33.8	37.1	44.2	38.3
2. ATS	1%	30-60%	Airblast	1000 L	38.5	36.7	47.3	40.9
3. ATS	1%	90-100%	Airblast	1000 L	37.6	34.3	34.9	35.6
4. ATS	1%	30-60%+90-100%	Quantum Mist	500 L	38.8	34.5	38.9	37.4
5. RALEX	2 L/ha	January 2008	Airblast	2000 L	*	*	*	*
6. Untreated Control	-	-	-	-	43.1	38.9	41.5	41.2
F Probability					ana	ana	ana	0.181
LSD 5%								ns

ns – not significant
* = fruit set counts not taken for RALEX

Table 29 Summary of Results – Trial 6 - Golden Queen - Cobram Victoria Mean 100 Fruit Weight (kg) at Stone Hardening (10-Nov-08) and at Harvest (18-Mar-09)

Treatment	Rate % v/v	Timing % Bloom	Application Equipment	Application Volume	100 Fruit Weight 10-Nov-08	100 Fruit Weight 18-Mar-09
1. ATS	1%	30-60%+90-100%	Airblast	1000 L	1.253	11.4
2. ATS	1%	30-60%	Airblast	1000 L	1.277	10.9
3. ATS	1%	90-100%	Airblast	1000 L	1.286	11.2
4. ATS	1%	30-60%+90-100%	Quantum Mist	500 L	1.331	10.6
5. RALEX	2 L/ha	January 2008	Airblast	2000 L	1.315	11.4
6. Untreated Control	-	-	-	-	1.279	11.2
F Probability					1.021	0.963
LSD 5%					ns	ns

ns = not significant

Table 30 Summary of Results – Trial 6 - Golden Queen – Cobram, Victoria Mean Fruit Size Distribution at Harvest (18-Mar-09)

Treatment	Rate % v/v	Timing % Bloom	Application Equipment	Application Volume	<57 mm	58-60 mm	61-63 mm	>63 mm
1. ATS	1%	30-60%+90-100%	Airblast	1000 L	18.2	40.2	26.6	15.0
2. ATS	1%	30-60%	Airblast	1000 L	16.5	37.8	32.0	13.7
3. ATS	1%	90-100%	Airblast	1000 L	8.3	29.9	39.2	22.6
4. ATS	1%	30-60%+90-100%	Quantum Mist	500 L	25.6	36.1	24.0	14.2
5. RALEX	2 L/ha	January 2008	Airblast	2000 L	14.7	31.2	30.5	23.6
6. Untreated Control	-	-	-	-	12.0	24.0	33.3	29.8
F Probability					0.106	1.210	1.020	0.720
LSD 5%					ns	ns	ns	ns

ns = not significant

5.2.2.6 Trial 7 – Golden Queen - Invergordon

Table 31 Summary of Results – Trial 7 - Golden Queen – Invergordon, Victoria Mean Percentage Fruit Set

Treatment	Rate % v/v	Application Timing	Application Method	Application Volume	Lower 31-Oct-08	Middle 31-Oct-08	Top 31-Oct-08	Overall 31-Oct-08
1. ATS	1%	40-60%+80-100%	Airblast	1000 L	66.9	80.5	72.8	73.4
2. ATS	1%	80-100%	Airblast	1000 L	71.4	74.3	70.1	71.9
3. ATS	1%	40-60%+80-100%	Quantum Mist	1000 L	71.2	75.3	68.1	71.5
4. ATS	1%	40-60%+80-100%	Quantum Mist	500 L	66.6	78.2	68.6	71.1
5. Untreated Control	-	-	-	-	72.9	75.3	71.9	73.3
F Probability					0.734	0.599	0.885	0.966
LSD 5%					ns	ns	ns	ns

ns = not significant

Table 32 Summary of Results - Trial 7 - Golden Queen – Invergordon, Victoria Mean 100 Fruit Weight (kg) at Stone Hardening (10-Nov-08) and at Harvest (13-Mar-09)

Treatment	Rate L/ha	Application Timing	Application Method	Application Volume	100 Fruit Weight 19-Nov-08	100 Fruit Weight 13-Mar-09
1. ATS	1%	40-60%+80-100%	Airblast	1000 L	1.32 b	11.1 b
2. ATS	1%	80-100%	Airblast	1000 L	1.38 b	11.5 b
3. ATS	1%	40-60%+80-100%	Quantum Mist	1000 L	1.38 b	11.7 b
4. ATS	1%	40-60%+80-100%	Quantum Mist	500 L	1.49 a	12.9 a
5. Untreated Control	-	-	-	-	1.38 b	11.7 b
F Probability					0.024	0.065
LSD 5%					0.10	1.01

Table 33 Summary of Results - Trial 7 - Golden Queen – Invergordon, Victoria Mean Fruit Size Distribution at Harvest (13-Mar-09)

Treatment	Rate L/ha	Application Timing	Application Method	Application Volume	<57 mm	58-60 mm	61-63 mm	>63 mm
1. ATS	1%	40-60%+80-100%	Airblast	1000 L	26.6	32.8	30.2	10.4
2. ATS	1%	80-100%	Airblast	1000 L	16.1	31.0	33.2	19.6
3. ATS	1%	40-60%+80-100%	Quantum Mist	1000 L	16.6	33.7	34.4	15.3
4. ATS	1%	40-60%+80-100%	Quantum Mist	500 L	8.6	20.4	30.4	40.6
5. Untreated Control	-	-	-	-	15.0	30.8	30.5	23.7
F Probability					0.213	0.643	0.411	0.722
LSD 5%					ns	ns	ns	ns

ns = not significant

Studies conducted in 2008/2009 compared the efficacy of ATS through a purpose built Quantum mist sprayer in trials conducted on Tatura 211 and Golden Queen. In each of the two trials conducted in Tatura 211, excellent fruit thinning was seen with the double application of ATS compared to a single application which further confirmed observations from the previous season. Single applications were mostly not as effective, although a numerical reduction in fruit set was generally seen. On Golden Queen, results were much less clear. Whilst significant differences were not always seen between application systems when applying at full volumes, data trends indicate that the Quantum mist sprayer may have been more effective.

No effective fruit thinning was seen in Tatura 204 in any of the application programs.

5.2.3 2009/2010 Trials

Results for the 2009/2010 efficacy studies are presented in Tables 34-41. They include data on fruit set and yield only. No detailed data for crop safety are given as all treatments were safe to peaches in each trial.

5.2.3.1 Trial 1 – Tatura 204 - Ardmona

Table 34 Summary of Results – Trial 1 - Tatura 204 - Ardmona, Victoria Mean Percentage Fruit Set (6-Nov-09)

Treatment	Rate % v/v	Timing % Bloom	Application Method	Application Volume	Lower	Middle	Top	Overall Fruit Set
1. Mechanical thinner	-	-	-	-	8.9 b	27.1	28.4 b	21.5 c
2. ATS	1%	30-60%+50-90%	Quantum Mist	1000 L/ha	20.2 a	34.3	49.2 a	34.6 ab
3. ATS	1%	30-60%+50-90%	Airblast	1000 L/ha	26.5 a	43.3	44.3 a	38.0 a
4. Untreated Control	-	-	-	-	24.4 a	28.4	40.3 a	31.0 b
F Probability					0.002	0.057	0.036	0.002
LSD 5%					7.3	ns	13.5	6.5

ns = not significant

Table 35 Summary of Results – Trial 1 - Tatura 204 - Ardmona, Victoria Mean 100 Fruit Weight (kg) at Stone Hardening (20-Nov-09)

Treatment	Rate % v/v	Timing % Bloom	Application Method	Application Volume	100 Fruit Weight
1. Mechanical thinner	-	-	-	-	2.7 a
2. ATS	1%	30-60%+50-90%	Quantum Mist	1000 L/ha	2.3 c
3. ATS	1%	30-60%+50-90%	Airblast	1000 L/ha	2.3 bc
4. Untreated Control	-	-	-	-	2.4 b
F Probability					<.001
LSD 5%					0.151

5.2.3.2 Trial 2 – Tatura 211 – Cobram

Table 36 Summary of Results – Trial 3 - Tatura 211 - Cobram, Victoria Mean Percentage Fruit Set (13-Nov-09)

Treatment	Rate % v/v	Timing % Bloom	Application Method	Application Volume	Lower	Middle	Top	Overall Fruit Set
1. ATS	1%	30-60%	Quantum Mist	1000 L/ha	37.1	40.5 a	48.5	42.0
2. ATS	1%	30-60%	Airblast	1000 L/ha	44.9	55.8 b	51.9	50.9
3. Untreated Control	-	-	-	-	47.7	53.4 b	55.8	52.3
F Probability					0.158	0.024	0.766	0.181
LSD 5%					ns	10.5	ns	ns

ns = not significant

Table 37 Summary of Results – Trial 2 - Tatura 211 - Cobram, Victoria Mean 100 Fruit Weight (kg) at Stone Hardening (20-Nov-09) and at Harvest (10-Feb-10)

Treatment	Rate % v/v	Timing % Bloom	Application Method	Application Volume	100 Fruit Weight 20-Nov-09	100 Fruit Weight 10-Feb-10
1. ATS	1%	30-60%	Quantum Mist	1000 L/ha	1.89 a	17.82 a
2. ATS	1%	30-60%	Airblast	1000 L/ha	1.72 b	16.42 ab
3. Untreated Control	-	-	-	-	1.69 b	13.71 b
F Probability					0.014	0.026
LSD 5%					0.1	2.7

Table 38 Summary of Results – Trial 2 - Tatura 211 - Cobram, Victoria Mean Fruit Size Distribution at Harvest (10-Feb-10)

Treatment	Rate % v/v	Timing % Bloom	Application Method	Application Volume	<57 mm	58-64 mm	65-71 mm
1. ATS	1%	30-60%	Quantum Mist	1000 L/ha	4.9 b	18.7 b	26.6
2. ATS	1%	30-60%	Airblast	1000 L/ha	7.8 b	29.9 b	38.5
3. Untreated Control	-	-	-	-	18.0 a	53.6 a	19.5
F Probability					0.045	0.009	0.063
LSD 5%					10.2	18.4	ns
Treatment	Rate % v/v	Timing % Bloom	Application Method	Application Volume	71-75 mm	>75 mm	
1. ATS	1%	30-60%	Quantum Mist	1000 L/ha	26.6 a	23.18 a	
2. ATS	1%	30-60%	Airblast	1000 L/ha	20.4 a	3.38 b	
3. Untreated Control	-	-	-	-	8.0 b	0.98 b	
F Probability					0.024	0.006	
LSD 5%					12.1	10.6	

ns = not significant

5.2.3.3 Trial 3 – Golden Queen – Invergordon

Table 39 Summary of Results – Trial 3 - Golden Queen, Invergordon, Victoria Mean Percentage Fruit Set (09-Nov-09)

Treatment	Rate % v/v	Timing % Bloom	Application Method	Application Volume	Lower	Middle	Top	Overall Fruit Set
1. ATS	1%	40-60%+100%	Quantum Mist	1000 L/ha	37.4	36.5 a	39.0 a	37.6 a
2. ATS	1%	40-60%+100%	Airblast	1000 L/ha	48.3	56.1 b	68.3 b	57.6 b
3. Untreated Control	-	-	-	-	42.9	55.9 b	72.2 b	57.0 b
F Probability					0.426	0.014	0.019	0.006
LSD 5%					ns	12.6	21.9	10.6

ns = not significant

Table 40 Summary of Results – Trial 3 - Golden Queen - Invergordon, Victoria Mean 100 Fruit Weight (kg) at Stone Hardening (20-Nov-09) and at Harvest (1-Mar-10)

Treatment	Rate % v/v	Timing % Bloom	Application Method	Application Volume	100 Fruit Weight 20-Nov-09	100 Fruit Weight 01-Mar-10
1. ATS	1%	40-60%+100%	Quantum Mist	1000 L/ha	1.77 a	15.91
2. ATS	1%	40-60%+100%	Airblast	1000 L/ha	1.66 ab	14.93
3. Untreated Control	-	-	-	-	1.64 b	14.90
F Probability					0.090	0.126
LSD 5%					0.125	ns

ns = not significant

Table 41 Summary of Results – Trial 3 - Golden Queen - Invergordon, Victoria Mean Fruit Size Distribution at Harvest (01-Mar-10)

Treatment	Rate % v/v	Timing % Bloom	Application Method	Application Volume	<57 mm	58-64 mm	65-71 mm
1. ATS	1%	40-60%+100%	Quantum Mist	1000 L/ha	8.1	19.1 b	62.7 a
2. ATS	1%	40-60%+100%	Airblast	1000 L/ha	10.6	21.8 ab	53.7 ab
3. Untreated Control	-	-	-	-	12.2	27.0 a	50.6 b
F Probability					0.608	0.059	0.043
LSD 5%					ns	6.35	9.2

Treatment	Rate % v/v	Timing % Bloom	Application Method	Application Volume	71-75 mm	>75 mm
1. ATS	1%	40-60%+100%	Quantum Mist	1000 L/ha	10.1	0.00
2. ATS	1%	40-60%+100%	Airblast	1000 L/ha	13.9	0.00
3. Untreated Control	-	-	-	-	9.2	1.02
F Probability					0.686	0.125
LSD 5%					ns	ns

ns = not significant

Significant differences were seen in fruit set in each trial conducted in Tatura 211 and Golden Queen. Fruit set from the Quantum mist sprayer treated blocks was significantly less than Untreated Controls and the standard airblast sprayer in each variety. Application of ATS through the Quantum mist sprayer resulted in significantly larger fruit at both stone hardening and commercial harvest.

When applied to Tatura 204 in a program ATS at 1% v/v failed to provide effective thinning.

5.2.4 2010/2011 Trials

Results for the 2010/2011 efficacy studies are presented in Tables 42-55. They include data on fruit set, fruit size and yield, plus thinning time in some blocks. No detailed data for crop safety are given as all treatments were safe to peaches in each trial.

5.2.4.1 Trial 1 – Tatura 204 Block 1 – Cobram, Victoria

Table 42 Summary of Results – Trial 1 - Tatura 204 Block 1 – Cobram, Victoria Mean Percentage Fruit Set

Treatment	Rate	Percentage Fruit Set			Overall %
	% v/v	Top	Middle	Bottom	Fruit Set
1. ATS	1.0%	78.5 b	56.5 b	24.5 a	53.1 b
2. ATS	1.5%	55.7 a	41.2 a	29.9 a	42.3 a
3. Untreated Control		74.9 b	54.8 b	38.0 a	55.9 b
F Probability		<.001	0.031	0.199	0.002
LSD 5%		10.1	13.3	ns	7.5

ns = not significant

Table 43 Summary of Results – Trial 1 - Tatura 204 Block 1 - Cobram, Victoria Fruit Hand Thinning Time per ha, Fruit Size at Stone Hardening and at Commercial Harvest, Total Fruit Yield per ha

Treatment	Rate % v/v	Fruit Thinning Time/ha	100 Fruit Weight Stone Hardening (g)	100 Fruit Weight Harvest (kg)	Total Yield Bins per ha
1. ATS	1.0%	14.5 hrs	2774	15.47	41.0
2. ATS	1.5%	14.8 hrs	3080	16.94	53.0
3. Untreated Control		23.0 hrs	2870	15.38	40.5
F Prob			0.158	0.034	ana
LSD 95%			ns	0.97	

ana = analysis not applicable
ns = not significant

5.2.4.2 Trial 2 – Tatura 211 Block 6B – Cobram, Victoria

Table 44 Summary of Results – Trial 2 - Tatura 211 Block 6B - Cobram, Victoria Mean Percentage Fruit Set

Treatment	Rate % v/v	Percentage Fruit Set			Overall % Fruit Set
		Top	Middle	Bottom	
1. ATS	1.0%	54.2 a	55.8 a	65.8 a	58.6 a
2. ATS	1.5%	64.8 a	59.0 a	71.2 a	65.0 a
3. Untreated Control		77.5 a	76.5 b	74.2 a	76.1 b
F Probability		0.382	0.001	0.382	0.003
LSD 5%		ns	10.9	ns	9.7

ns = not significant

Table 45 Summary of Results – Trial 2 - Tatura 211 Block 6B - Cobram, Victoria Mean Fruit Weight at Stone Hardening and at Harvest

Treatment	Rate % v/v	25 Fruit Weight Stone Hardening	50 Fruit Weight Harvest
1. ATS	1.0%	462 a	7499 a
2. ATS	1.5%	462 a	8066 a
3. Untreated Control		426 b	8030 a
F Probability		0.002	0.058
LSD 5%		30.0	ns

ns = not significant

Table 46 Summary of Results – Trial 2 - Tatura 211 Block 6B - Cobram, Victoria - Fruit Size Distribution at Harvest (mm Diameter)

Treatment	Rate % v/v	<57	57 - 67	67 - 70	70 - 73	>73
1. ATS	1.0%	11.0 a	27.5 a	9.8 a	1.8 a	0.3 a
2. ATS	1.5%	13.5 a	22.0 a	12.8 a	3.0 a	0.3 a
3. Untreated Control		9.5 a	21.0 a	15.3 a	4.8 a	1.0 a
F Probability		0.685	0.105	0.239	0.202	0.371
LSD 5%		ns	ns	ns	ns	ns

ns = not significant

Table 47 Summary of Results – Trial 2 - Tatura 211 Block 6B - Cobram, Victoria – Total Fruit Yield per Block

Treatment	Rate % v/v	Total Yield Bins per ha
1.ATS	1.0%	44
2.ATS	1.5%	48
3.Control		54
F Prob		ana
LSD 95%		

ana = analysis not applicable

5.2.4.3 Trial 3 – Tatura 211 Block 14B – Cobram, Victoria

Table 48 Summary of Results – Tatura 211 Block 14B - Cobram, Victoria Mean Percentage Fruit Set

Treatment	Rate % v/v	Percentage Fruit Set			Overall % Fruit Set
		Top	Middle	Bottom	
1. ATS	1.0%	69.4 a	53.8 a	57.4 a	60.2 a
2. ATS	1.5%	72.1 a	55.6 a	48.1 a	58.6 a
3. Untreated Control		66.6 a	79.8 b	78.4 a	74.9 b
F Probability		0.909	<.001	0.057	0.023
LSD 5%		ns	11.9	ns	12.2

ns = not significant

Table 49 Summary of Results – Trial 3 - Tatura 211 Block 14B - Cobram, Victoria Mean Fruit Weight at Stone Hardening and at Harvest

Treatment	Rate % v/v	25 Fruit Weight Stone Hardening	50 Fruit Weight Harvest
1. ATS	1.0%	559 ab	7757 a
2. ATS	1.5%	607 a	7995 a
3. Untreated Control		525 b	7392 a
F Probability		0.019	<.001
LSD 5%		49.6	864.1

Table 50 Summary of Results – Trial 3 - Tatura 211 Block 14B - Cobram, Victoria Fruit Size Distribution at Harvest (mm Diameter)

Treatment	Rate % v/v	<57	57 - 67	67 - 70	70 - 73	>73
1. ATS	1.0%	8.8 a	20.8 a	11.3 a	4.8 a	4.8 a
2. ATS	1.5%	5.8 a	20.8 a	15.5 a	6.3 a	2.5 a
3. Untreated Control		11.3 a	21.5 a	7.3 b	6.8 a	3.8 a
F Probability		0.237	0.977	0.035	0.209	0.774
LSD 5%		ns	ns	5.8	ns	ns

ns = not significant

Table 51 Summary of Results – Trial 3 - Tatura 211 Block 14B – Cobram, Victoria Total Fruit Yield per block

Treatment	Rate % v/v	Total Yield Bins per Block
1.ATS	1.0%	24
2.ATS	1.5%	27
3.Untreated Control		26
F Prob		ana
LSD 95%		

ana = analysis not applicable

5.2.4.4 Trial 4 – Golden Queen Block 12B – Cobram

Table 52 Summary of Results – Trial 4 - Golden Queen Block 12B - Cobram, Victoria - Mean Percentage Fruit Set

Treatment	Rate	Percentage Fruit Set			Overall %
	% v/v	Top	Middle	Bottom	Fruit Set
1. ATS	1.0%	43.5 a	45.8 ab	26.7 a	38.7 a
2. ATS	1.5%	47.3 a	38.6 a	34.9 a	40.2 a
3. Untreated Control		60.7 b	52.7 b	52.3 b	55.3 b
F Probability		0.020	0.050	0.011	<.001
LSD 5%		12.2	11.2	16.3	7.6

Table 53 Summary of Results – Trial 4 - Golden Queen Block 12B - Cobram, Victoria - Mean Fruit Weight at Stone Hardening and at Harvest

Treatment	Rate	25 Fruit Weight	50 Fruit Weight
	% v/v	Stone Hardening	Harvest
1. ATS	1.0%	694 a	7735 a
2. ATS	1.5%	770 a	8475 a
3. Untreated Control		718 a	7690 a
F Probability		0.056	0.867
LSD 5%		ns	ns

ns = not significant

5.2.4.5 Trial 5 – Golden Queen Block 29B – Cobram, Victoria

Table 54 Summary of Results – Trial 5 - Golden Queen Block 29B - Cobram, Victoria - Mean Percentage Fruit Set

Treatment	Rate % v/v	Number of Applications	Percentage Fruit Set			Overall %
			Top	Middle	Bottom	Fruit Set
1. ATS	1.0%	1	48.5 a	51.5 ab	42.2 a	47.4 a
2. ATS	1.0%	2	55.6 a	43.1 a	39.4 a	46.0 a
3. ATS	1.5%	1	52.5 a	48.7 a	37.3 a	46.2 a
4. ATS	1.5%	2	50.9 a	45.5 a	35.4 a	43.9 a
5. Untreated Control			52.2 a	61.7 b	49.4 a	54.4 a
F Probability			0.816	0.045	0.351	0.151
LSD 5%			ns	12.6	ns	ns

ns = not significant

Table 55 Summary of Results – Trial 5 - Golden Queen Block 29B - Cobram, Victoria - Mean Fruit Weight at Stone Hardening

Treatment	Rate % v/v	Number of Applications	25 Fruit Weight Stone Hardening
1. ATS	1.0%	1	512.3 a
2. ATS	1.0%	2	538.8 a
3. ATS	1.5%	1	567.8 a
4. ATS	1.5%	2	563.5 a
5. Untreated Control			520.3 a
F Probability			0.110
LSD 5%			ns

ns = not significant

Significant fruit thinning was seen in the Tatura 204 study where ATS was applied twice at 1.5%. Significant thinning was also seen in two Tatura 211 studies and one Golden Queen study where ATS was applied once. Significant increases in fruit size were also seen at stone hardening, prior to hand thinning, but not at commercial harvest. Block yield was measured in the Tatura 204 and the Tatura 211 studies. Whilst the figures are absolute, no real difference was seen in Tatura 211, however in the Tatura 204 study 25% more fruit were picked from the block treated with ATS at 1.5%.

For the Tatura 204 study, thinning time in the Untreated Control was 23 hours/ha compared to 14.8 hours/ha in the block treated with ATS at 1.5%.

5.2.5 Crop Safety

The safety of applying ATS through conventional spraying systems in the absence of a non ionic wetting agent was demonstrated in each year of the study. Multiple applications were shown to be safe, when treatments were made through a conventional airblast sprayer. In each of the trials the application of ATS did not cause any unacceptable damage, although slight shoot burn was observed in the lower levels of Tatura 204 and in Tatura 211 trees where a triple application was done. Over each of the ensuing seasons varying weather conditions occurred at spraying. Byers (1989) noted that rewetting caused by light rain may cause phytotoxicity. In one study on Tatura 204 conducted in 2009, 2 mm rain fell on the night following application and a heavy fog did not lift until late morning on the following day. Such conditions would be considered ideal for rewetting phytotoxicity, but none was seen. Further, in the final year of the study, application rates of 1.5%/v/v were applied in volumes of around 700 L/ha (targeted to the top half of the tree canopy) and again no adverse effects were observed.

6. DISCUSSION

The use of ammonium thiosulphate (ATS) in canning peaches has been traditionally restricted due to concerns with crop safety and over thinning through misapplication. Careful ATS application, over the four years of this study have shown that when applied at a concentration of 1-1.5% it is safe to the major canning varieties Tatura 204, Tatura 211 and Golden Queen, allaying fears of over thinning.

When applied at these rates effective thinning can be reliably attained, but it is essential that two applications at the correct are made. Determining the best timing to apply ATS is critical to performance and it is important the flowers in the top third of at least 20 trees in a block be monitored to accurately assess this.

The narrow application window presented for ATS application introduces a variable which can make widespread uptake difficult. Accurate application timing is affected by weather conditions and the ability to cover large orchard areas in the short time available. Poor weather conditions in some years or very warm conditions during others, which shorten the flowering period remarkably, can mean the ability to complete a double application may not be possible.

The introduction of a mechanical thinning unit (which was shown to be very effective in 2008/2009) has given growers another reliable and effective alternative. This system is really only effective on crops grown on two dimensional architecture and cannot be used on conventional vase shaped trees, but has been widely adopted by growers who have planted these training systems.

This project has provided information to all canning peach growers on how best to apply ATS and most growers have now been evaluating its performance through their individual application units. Data on exact ATS usage are not available but information obtained from local agronomists indicate that around 60% of canning peach growers now incorporate ATS into their thinning program annually with over 100 ha being treated in 2011. Familiarity with the product's use will see uptake increase in the three seasons following the completion of the project but cannot be measured at this time.

A canning peach thinning manual has been prepared which covers the following topics:

- How best to understand flowering in canning peaches and to accurately determine what flowering stage a block is at.

- The optimum application regime for ATS in Tatura 204, Tatura 211 and Golden Queen and how best to apply the product to get maximum performance.

Full gross margins analysis were not completed for each of the blocks in 2010, due to misunderstandings in recording total yield or hand thinning times. However a simple analysis of the thinning costs compared with the early thinning benefit was completed for Tatura 204. The data indicate that an increase in the net returns/ha in the order of $4,000/ha can be expected, after thinning cost have been removed.

7. TECHNOLOGY TRANSFER

Field days were conducted in each year of the study. Project reviews were presented to the CFICA and industry in three years of the term of the study. In addition, small field days for individual groups were held on some occasions.

Date	Grower Field Day
November 2007	Invergordon
November 2008	Cobram
November 2009	Ardmona

Date	Industry Meetings
June 2008	Meetings with Gro-Chem to discuss project design
July 2008	Cobram stone fruit growers' meeting
July 2009	Cobram stone fruit growers' meeting

Attendance at the field days varied from 2-30 growers and industry representatives.

Regular meetings were held with SPC Ardmona staff to review progress on the project and discuss modifications to the project over time.

Data generated from this project will be used in product registrations for ATS and as such will not occur for some time following the project's completion. Companies who manufacture ATS have been included in the study and have been regularly consulted throughout the course of the project and will be involved in technology transfer following product registration which result from this work.

A range of other written material was produced including milestone reports and articles for magazines.

Canning Fruit Thinning Manual

A grower resource document has been prepared detailing options for fruit thinning in canning peaches.

Gross Margins Analysis – Tatura 204 – Trial 2010

An analysis of thinning costs and yield benefit has only been conducted for one study in Tatura 204.

Attempts to measure this in other studies was made difficult by not being able to obtain accurate measures of either yield or thinning time.

Total fruit yield was measured for each of the treated blocks and then the hand thinning times and the direct cost of chemical thinners and application were incorporated into the production costs for each block.

Otherwise each block was treated in the same manner and an assumption made that all other costs were the same.

For Tatura 204 a significant increase in gross return following accounting for thinning costs of $4,189 was achieved, after accounting for thinning cotst.

	Hand Thin	**ATS 1.5% v/v**
Yield/ha	40.5 bins	53 bins
Gross Price/Bin	$330	$330
Gross Return/ha	**$13,365**	**$17,490**
Thinning Cost		
Chemical Cost/ha		$67
Application Cost/ha		$25
Hand thinning Time/ha	23 hrs	14.8 hrs
Cost/hr	$19	$19
Hand Thinning Cost/ha	$437	$281.2
Total Thinning Cost	**$437**	**$373**
Return/ha After Thinning	**$12,928**	**$17,117**

8. RECOMMENDATIONS

The major outcome of this project is that speculation over the use of ATS as a blossom thinner in canning peaches has been clarified. The study results demonstrate that when application timing is correct, and the application itself is optimum, excellent fruit thinning can be achieved. Single applications at 1% v/v, or incorrect application timing (i.e. too late) will offer no significant benefit.

Sufficient data have been generated to support the label extension registration for an ATS application rate of 1.5% v/v in canning peaches.

A program of grower evaluations is recommended to confirm these findings.

The use of ATS however forms only part of an integrated approach which is required to achieve effective crop load management. Effective pruning, chemical thinning followed by timely hand thinning will result in maximum yield beings consistently achieved.

A program to improve understanding of the need for accurate product application, selection of appropriate use rates and determining when crops are at the correct stage for spraying is recommended.

9. ACKNOWLEDGMENTS

Agrisearch staff who contributed to this project included: Angus Crawford, Joel Gorman, Marco Montagna and Cyril Tricarico.

The assistance of Simon Mills and Patrick Mehan from SPC Ardmona in providing feedback and organising field days was invaluable.

Growers who provided sites included: Max Wright, James Cornish, Peter Kemp, Ang Diaco, Andrew Lenne and Andrew Plunkett.

Constructive criticism from Russell Fox was greatly appreciated.

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CROP LOAD MANAGEMENT AND IMPROVED THINNING PRACTICES IN CANNING PEACHES

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Background

Effective thinning of canning peaches is essential to produce large crops of even sized fruit in the range of 57-70 mm.

Traditionally, hand thinning has formed the basis of setting crops to their optimum crop loads. Hand thinning is best done within 60 days to achieve maximum benefit. However the earlier fruit are thinned, assuming normal fruit set, the better will be the result.

The blossom thinner ammonium thiosulphate (ATS) has been available to growers for over 10 years and has been used with mixed results in canning fruit orchards.

More recently the Darwin mechanical thinner has been used with very good results, but its success was limited to thinning in trellis or planer design orchards.

For traditionally grown vase shaped trees an integrated approach of chemical thinning combined with hand thinning is currently the best option.

Work completed by Emil Somers during the 1990's defined target crop loads for varying tree architectures and set the basis for effective thinning practice.

Introduction

This brochure is a guide to effective crop load management in canning peaches. It provides an overview of crop thinning methods based on research conducted for Horticulture Australia Limited. There are 3 key steps to effective crop load management. These are:

1. Effective pruning
2. Identification of the likelihood of good fruit set, based upon winter chill and previous history
3. Development of a fruit thinning strategy to suit the planting method and budget

Early fruit growth depletes starch reserves held in the trunk shoots and leaves. The longer thinning is delayed, increasingly less starch reserves will be available for the remaining developing fruit.

Pruning

Since peaches are borne only on 1 year old laterals, the yield depends entirely upon the number of laterals that are left on the tree after the tree has been pruned. A lateral is a shoot which is about 300 mm long and about 5-10 mm thick. It has many triple buds. These laterals are easily found in the tops of trees, but lower in the canopy the laterals are often short and thin with single buds.

Figure 1: Well Pruned Tree

Effective cropping starts in the winter with pruning. Inspect the trees before you commence and try to work out how many laterals you have per tree and where the best laterals may be in the tree. As a guide you should have at least 7-8 laterals for every centimetre of trunk circumference. To assess this, measure the girth of ten trees in each block and determine the number of laterals required to meet this target. It is important to assess the quality of the laterals as there may be a deficit of good laterals and 2-3 short laterals could be counted as one good lateral.

The importance of arriving at the correct crop loading commences with pruning. This is just given as a guide to the importance of this first step. Further details of effective pruning are contained the booklet “Training and pruning peach, plum and apricot trees” by Bas Van den Ende.

Crop Loading

The amount of fruit peach trees can produce is determined at pruning, by leaving a certain number of laterals on the trees according to the size of the trees as measured by trunk circumference.

Figure 2: With this graph you can work out how many laterals you should leave on your peach trees after winter pruning. Use the bottom line for the average trunk circumference of your block of peach trees. Where the vertical line crosses the graph you can determine how many laterals you should leave on your trees. A lateral is about 20-30 cm long.

Once you know the trunk circumference you can work out how many laterals to leave on a tree and then the number of fruit you should aim to carry to optimise the crop loading. Varieties like Tatura 204 and Tatura 211 can carry 3 fruit per lateral and Queen varieties 2.5-3 fruit per lateral.

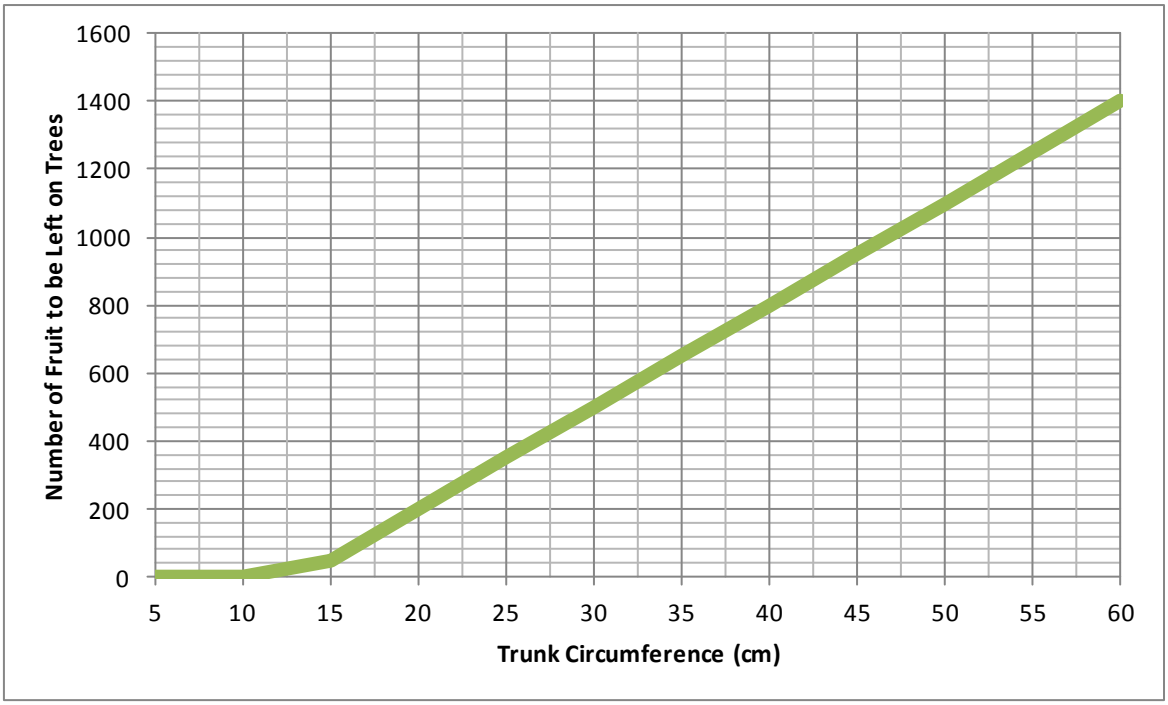

Figure 3 **Target crop loads for Tatura 204 based upon trunk circumference. Where the vertical line from the average trunk circumference crosses the graph you can read the number of fruit you should leave on your trees.**

Thinning

Traditionally thinning has been completed by hand near to the 'Reference date', which is a round 10 days after tip change, generally in mid-November for most cling peach varieties in the Goulburn Valley. The size of the fruit at the reference date is highly correlated with fruit size at harvest.

Because early fruit growth depletes starch reserves held in the trunk, shoots and leaves, the longer thinning is delayed, increasingly less starch reserves will be available for the remaining developing fruit.

Thus to be most effective thinning should be completed as near to flowering as possible and certainly before the reference date.

Hand thinning can be an expensive exercise and methods have been developed to thin peach trees earlier and more cheaply.

Mechanical Thinning

The Darwin Fruit thinner has recently been introduced into Australian orchards and has proven to be very effective on canning peaches. However the system works in a 2 dimensional set up and as such is best suited for thinning trees planted on a Tatura trellis or planar central leader architecture.

The machine is attached to the front hydraulic system of the tractor or to the coupling mouth by means of an expander. The vertical spindle has 600 millimetre strings attached and the number of strings can be varied.

A hydraulic adjustment of the spindle allows it to be inclined to suit the tree form being thinned. The speed of the spindle can be adjusted independently of the speed of the tractor, so both tractor and spindle speed can be used to adjust the thinning rate. The thinning rate can be varied from zero to 100 per cent. The preliminary data indicated that the thinning results at 20% full bloom were similar to thinning at 80% full bloom. When considering thinning, you should also look at the bloom stage. This gives you the opportunity to observe and adjust the Darwin to determine the desired thinning effect(s) associated with the optimal settings of the mechanical blossom thinner. Additional confidence will come after multiple seasons of use. A suggested starting level is with small trial sizes or test plots.

Chemical Thinning

For trees grown on traditional vase shape architecture the use of the Darwin mechanical thinner is not an option. Chemical thinning during the blossom period is an effective and potentially cheap method of manipulating crop loads to near the targets, at a time in the season when maximum benefit in terms of early fruit growth can be achieved.

The use of ammonium thiosulphate (ATS) has been extensive for many seasons but fear of over thinning and variation in the results achieved has limited the product's use in canning peaches.

ATS acts as a desiccant or burner of the reproductive flower parts and prevents pollination from being completed and therefore flower abortion. The period for pollination can be from 24-72 hours in Goulburn Valley peach orchards so it is critical that the product is applied at the correct timing and before pollination is complete.

To get the best from the product it is essential that you understand the following:

1. The flowering stage of trees and adopting the correct timing
2. Using well calibrated equipment which will deliver ATS accurately to the target area
3. Using an appropriate application rate and volume to achieve a positive thinning result with no crop damage.

Flowering in Peach Trees

Flowering patterns vary significantly within peach blocks, both within trees and between trees in a block. It is essential, if you are to get the best from ATS, that you understand exactly what stage the flowering is at and how much variability there is within the block. The following figure shows the variability in a block of Tatura 211 which may be seen during a normal flowering season:

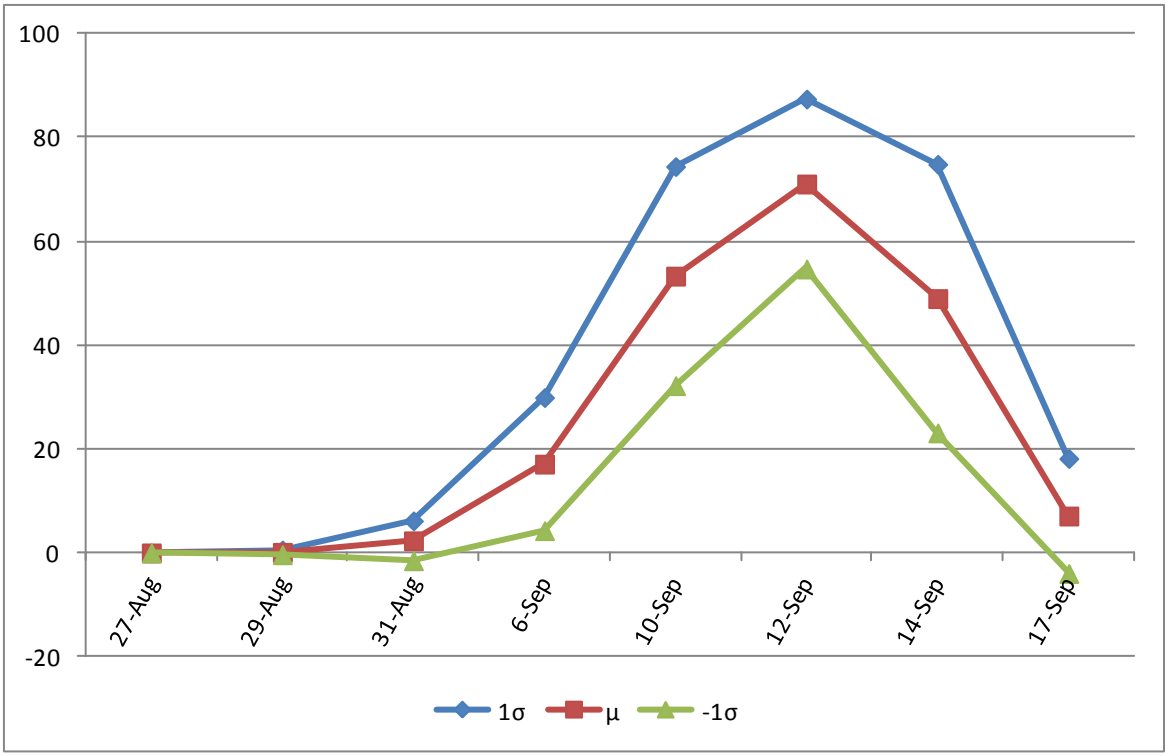

Figure 4 Percentage of Flowers Open and Flowering Variance Within the Block for the Top Sections of the Tree for Tatura 211

Thus there can be a variance of up to 40% in the flowering stage between trees in the same block. To spray accurately the average flowering stage in the block must be determined. Walk through each block and randomly select 20 trees. Count the total number of flowers on ten terminals in the top ½ of each tree and then record the number which are open and theoretically susceptible to ATS. Later in the flowering cycle it is also important to understand that once pollination has been completed, ATS will no longer be effective. As a guide, follow the rule that once a flower has lost 1-3 petals then pollination has been completed or is nearly complete. Thus the most susceptible flowers are those which have just or recently opened and are entire. Treatments must be applied when the block average in the top ½ of the tree is at or near the desired average for each application.

The duration of flowering is also important to enable a full program of ATS to be completed and to achieve the best thinning result. It must be remembered that the application window for successfully using ATS is quite narrow and can be impacted further by varying weather conditions. For example, if weather conditions are warm (i.e.>25^{o}C) then flowering may be complete in just a few days making it difficult to treat the area twice in a short time. On the other hand wet or adverse weather conditions may make it impossible to apply the treatments at the correct timings. The flowering period in 2007, 2008, 2009 and 2010 for each of the major varieties is given below and demonstrates this variability.

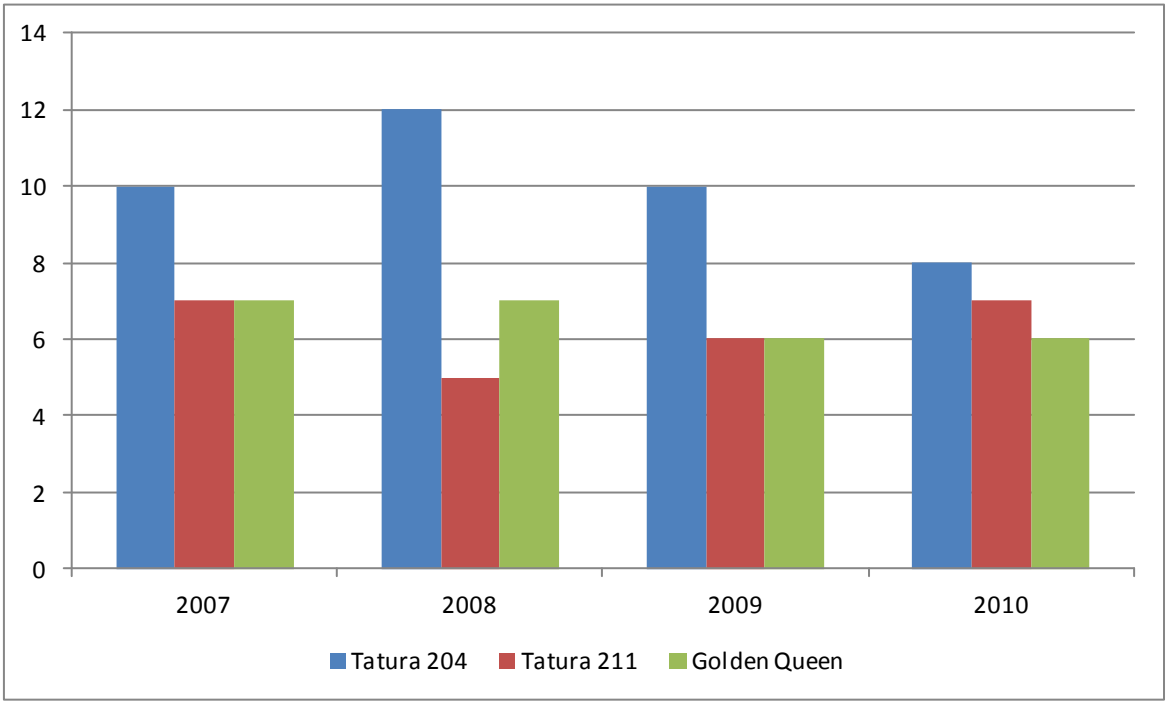

Figure 5 Application Window Time for ATS Over Four Seasons. Estimated Time From 20% Flowering to Full Bloom

Application Timing

Once the flowering stage of the trees is determined it is important to apply ATS at the correct stage. Work completed over the past 5 years has shown that a more consistent result will be achieved when a double application can be made. The following table provides an example from one trial (of many trials completed) in 2008 which clearly showed this result to apply:

Mean Percentage Fruit Set - Tatura 211 - Ardmona, Victoria – November 2008

Treatment	Rate % v/v	Timing % Bloom	Application Volume	Lower	Middle	Top	Overall Fruit Set
1. ATS	1%	30-40%+50-80%	800 L	44.1 a	67.1	45.4 a	52.2 a
2. ATS	1%	30-40%	800 L	61.9 b	64.2	55.1 ab	60.4 bc
3. ATS	1%	50-80%	800 L	72.9 b	58.3	61.3 b	64.2 cd
4. Untreated Control	-	-	-	71.0 b	71.6	62.0 b	68.2 d
LSD 10%				12.2	ns	9.7	5.9

ns = not significant
Means with small letters next to them in common were not significantly different

The optimum timings for the ATS application are at around 30-50% and 60-90% of flowers open in the top ½ of the tree.

It is critical to accurately assess the flowering stage in your block. This cannot be done just visually, direct counts need to be completed. Walk through each block and count 20 laterals on the top half on each of 20 trees in each block. Count the total number of blossoms and the number which are open for each lateral. The percentage flowering for the whole block can then be estimated by the following:

$$\frac{\text{(Number of open flowers)}}{\text{(Total number of flowers)}} \times 100$$

Application Rate

The application rate for ATS has been an issue since the product was registered and needs to be clearly understood. ATS is registered to be applied on a concentrate basis with the actual volume per hectare applied being a factor of the water volume used. To ensure that the correct rate is applied, sprayers need to be well calibrated using new or near new nozzles with no evidence of wear, and set to produce an even spray pattern. *Treatment applications must also be targeted into the top ½ of the tree into the area where most fruit is produced.*

For Tatura 211, Tatura 222 and the Queen varieties a concentration of 1 L/100 L, when applied in a volume of up to 1000 L/ha, is effective. Using application volumes in excess of 1,100 L/ha may lead to a higher rate per ha of ATS and to excessive flower and shoot burning.

For Tatura 204, ATS application has been extremely variable or ineffective when using this rate. Field trials completed in 2010 have shown that best results are obtained when an application rate of 1.5% v/v (1.5 L/100 L), in a volume of at least 700 L/ha is used.

Tatura 204 – Cobram, Victoria – Mean Percentage Fruit Set - November 2010

Treatment	Rate	Percentage Fruit Set			Overall %
	% v/v	Top	Middle	Bottom	Fruit Set
1. ATS	1.0%	78.5 b	56.5 b	24.5 a	53.1 b
2. ATS	1.5%	55.7 a	41.2 a	29.9 a	42.3 a
3. Untreated Control		74.9 b	54.8 b	38.0 a	55.9 b
LSD 5%		10.1	13.3	ns	7.5

ns = not significant
Means with small letters next to them in common were not significantly different

If the application has been completed through well calibrated equipment then there is little or no likelihood of crop damage occurring as a result of ATS treatment as shown by the results of field trials from 2007-2010.

ATS has been applied at 1 L/100 L in a volume of 1000 L/ha or at 1.5 L/100 L in 700 L/ha over all of the main varieties without any sign of crop damage.

Application Equipment

Whilst air-blast equipment is very effective at applying conventional pesticides, spray distribution throughout the full tree profile can be variable. The use of ATS, where a low dosage with small margin for error is required, may not be appropriate through this type of spray equipment. The South Australian Research and Development Institute have developed the Quantum mist sprayer using a multi-head spraying concept which is now widely used in viticulture. This concept combines the advantages of providing excellent coverage of even and medium spray particles, where the spray deposit is delivered at a horizontal or near horizontal spray angle and nearer to the target. Conventional air-blast equipment spray particles from a more vertical angle at greater distances from the target. Further, a conventional air-blast unit generally delivers a broader range of spray droplet sizes than the Quantum mist sprayer. The concept is based on the theory that large volumes of low velocity air as a direct blast with no ducting or bending of the airstreams, gives the best coverage.

Field trials conducted over three years have shown that application of ATS through such spraying equipment will give a more consistent and better thinning result than through a conventional air-blast unit. The following results were obtained from a field trial conducted on Tatura 211 at Cobram in 2008.

Tatura 211– Cobram, Victoria

Treatment	Rate	Timing	Application	Application Volume	Overall Fruit Set	100 Fruit Weight 10-Nov-08	100 Fruit Weight 20-Feb-09
	% v/v	% Bloom	Equipment				
1. ATS	1%	30-40%+50-80%	Air-blast	1000 L	60.7 ab	1.319 ab	9.62 ab
2. ATS	1%	30-40%+50-80%	Quantum Mist	1000 L	58.8 a	1.390 a	10.14 a
3. Untreated Control	-	-	-	-	66.4 ab	1.190 c	9.03 bc
LSD 10%					8.300	0.0989	0.760

Means with small letters next to them in common were not significantly different

However, whilst research has shown that this may be the best way to apply ATS on canning peaches there are practical limitations to the use of the equipment. Firstly, the units are expensive and most peach growers still operate air-blast or turbomiser sprayers. Secondly, the fans are mounted on towers. Tree architecture in many traditional plantings means main branches spread well into the inter row spaces. Therefore it is difficult for the sprayer to move along the row without hitting trees.

Figure 6 Air-blast vs Quantum Mist Sprayer in Operation

In the short term conventional sprayers will remain as the major method of applying ATS. Under these conditions it is essential to follow the following guidelines:

- Remove or turn off the bottom 4-6 nozzles on either side of the spray bar, so that the spray concentration is targeted at the top half of the tree only.

- Use new of near new nozzles in the remainder of the unit incorporating nozzles which produce a finer spray droplet size and calibrate the sprayer to deliver an application volume of between 700-1000L per sprayed ha.

Follow up Hand Thinning

Regardless of the thinning management strategy followed it is critical to assess the crop load and fruit size prior to the reference date. Whole tree counts, measuring actual crop load compared to the target, for the tree butt circumference, is the only way to determine if target crop loads have been achieved. By this time the only way to further reduce crop loads to the target is by hand thinning. If the early crop load management strategies have been successful then this should not be too great a task.

Conclusions

Achieving maximum crop yield from your canning peach trees starts with pruning and understanding the crop load which your trees can carry to produce a crop of optimum sized fruit for canning. Fruit thinning is fundamental to this being achieved. Check off on each of these steps and optimum yields should be achieved:

1. Prune trees to the correct lateral load for the tree size
2. Chemical or mechanically thin fruit during the flowering period to maximise nutrient usage into fruit which will be harvested
3. Follow up with crop load counts and hand thinning prior to the reference date

References

Van den Ende, B. Training and Pruning Peach, Plum and Apricot Trees. *Proceedings of a one-day workshop 1998.*

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"The fruit thinning research program was funded by HAL using the voluntary contributions from the Canned Fruits Industry of Australia and matched funds from the Australian Government".
