Horticulture Innovation Australia

Final Report

National Cherry Development Program

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Content

Summary

The National Cherry Development Program (NCDP) addressed the need for an industry development and extension strategy to support the goals of the Australian Cherry Industry. The program achieved its aim of better informed industry members and greater uptake of levy-funded Research and Development (R&D) findings. The program engaged researchers with regional and local grower issues, developed collaborative links between state associations, agencies and private agribusiness providers across Australia. In addition, the program provided active, open collaborative exchanges between regions, state associations, and the national cherry grower association and from individual grower's to the national body. This process enabled a flexible and responsive program that is highly agile and capable of finding solutions to grower problems and priorities as they arise.

Project activities included field days, formal and informal presentations, training sessions, workshops and the delivery of the latest research information from international and domestic researcher's to Australian cherry growers. These activities were undertaken in five states (NSW, Vic, Tas, SA and WA) from 2013 to 2017 and allowed Australian cherry growers to have direct access to domestic researchers and world leading international cherry researchers Prof Lynn Long and Marlene Long of Oregon State University and Associate Professor Mathew Whiting from Washington State University. Further activities involved consultant Mr. Peter Morrison, who provided practical informal in-field information sessions on solutions to grower problems. The program provided support, and collaborated with the Cherry Export Working Group and the Department of Agriculture and Water resources (DAWR) through training sessions on export management. Other activities included contributions to the Cherry Industry Biosecurity Management Program, Export Manual development, Crop Monitoring for Export, training on protocols for China exports, spray diary and record keeping for pest and disease control measures.

Consultation with industry growers, representatives and stakeholders resulted in delivery of key outputs on crop monitoring and orchard management guides, Integrated Pest and Disease Management (IPDM) calendar, crop monitoring guide and 32 pest and disease factsheets. Yearly updates of the export manual and Minimum Residue Level (MRL) chemical protocols for restricted and unrestricted export markets were delivered. Road show events were held in five states and different regions in 2013, 2014, 2015, 2016 and 2017 based on priorities set by the NCDP reference group and cherry growers. Eight articles were produced for the Cherry Newsletter on the progress of NCDP and nine articles and presentations placed on the Tasmanian Institute of Agriculture (TIA) website for growers to access. A mid-term review was conducted in 2015 and an end-of-project review conducted in September 2016. Findings from this review were incorporated into a research paper that is being presented at the International Society of Horticultural Science (ISHS) International Cherry Symposium in Japan. This paper highlights how effective this project was at improving the Australian Cherry Industry.

Introduction

The Australian cherry industry is developing and expanding at a considerable rate. In 2000, the industry produced approximately 6,985 tonnes and by 2010 this had increased to 14,443 tonnes (ABS data). Due to this expansion, a crucial need was identified to provide growers with the opportunity to build capacity that ensured they are at the leading edge of technology and information. For this industry to move forward sustainability, the ability to deliver research outcomes, technologies and information to all industry growers is crucial. Due to the diversity of types and size of farming enterprises and operations, climatic growing regions, and logistical and economic requirements, an industry driven and regionally coordinated extension delivery method was needed. The program to be implemented was to avoid market oversupply situations, inconsistencies in fruit quality and yield, and boom bust cycles for growers. The Australian Cherry Strategic Investment plan 2012-2017 set out the objective “To ensure the Australian cherry industry has appropriate and sufficient capacity to manage change and industry expansion” (Objective 3). There is a crucial need for on-going communication, providing access to the most up-to-date information on cherry production in Australia and overseas. There was a clear and increasing demand from industry members for high quality information on technical production management practices and up-to-date market information. It was important that information be provided in a collaborative and interactive manner, but also critical that providers of information be involved and highly interested in the industry.

The National RD&E framework asked for a process and concept that included a central hub through which regional development and local extension activities could occur. A series of successful road shows involving Tasmanian Institute of Agriculture (TIA) and collaborative researchers had occurred in 2009, 2010 and 2011. Research and extension outcomes were presented to industry in 2012 at the national Cherry Growers Australia (CGA) levy-payers meetings and the Victorian Cherry Growers association Annual General meeting (AGM). TIA has many international cherry industry contacts, access to leading researchers and works collaboratively on projects that are highly relevant to the cherry industry as well as having the capacity to manage tenders and share in development of practical skills and knowledge though horticultural practitioners and consultants. Networking and discussions around developing a national extension program had taken place for several years between industry and TIA. This led to a common understanding that a national extension approach was required for the cherry industry. Dialog between CGA and its members and the research community proposed that a national framework using a coordinated approach has considerably greater impact than individual isolated extension units. Furthermore, a nationally coordinated project provides a basis for assessment of an extension strategy that could move emphasis from purely reactive to a comprehensive long-term strategically planned approach that incorporates a pre-emptive focus on immediate and future industry issues. The national development program was a logical progression from the status quo and ensured maximum national impact and benefit from investment of cherry industry levy research funds. Therefore, TIA was well placed to lead a coordinated program, ensuring that the program decisions regarding topics and presentations would be collaborative.

Methodology

Participatory research, industry participation and knowledge transfer.

A participatory approach was used for this National Cherry Development Program (NCDP), comprising of orchard in-field participatory events and extension events in New South Wales (NSW), Tasmania (TAS), South Australia (SA), Victoria (Vic) and Western Australia (WA). In addition, the ability of State associations to link issues and the timing of events was also considered. The NCDP events are conducted over a full day at times determined by the NCDP reference group between May and July depending upon the availability of domestic and international researchers, consultants, growers and guest speakers. The focus of activities and topics was determined by the grower bodies (state associations) during the previous season with the aim of developing grower skills to enhance fruit quality. This approach was focused at allowing the grower skills to be improved and information easily adopted to support the development of the Australian cherry industry initiatives.

For each extension event at least two presenters provided the latest information on industry issues and or regional issues facing growers. The presenters at these events consisted of a consultant and invited guest speaker, either a researcher, marketing or consumer expert or leading grower. Overall, the program sought to:

- improve fruit quality from a marketing or commercial perspective
- improve the fruit quality required for export
- assist growers to meet the new challenges in management of regulations
- simply explain and demonstrate the science behind the techniques
- assist growers to understand new services or systems that can be accessed (e.g. climate forecasting)
- assist and enhance grower ability to set priorities and make practical decisions quickly
- provide assistance on risk analysis to aid decision making
- provide practical outcomes of particular techniques in orchards

Presentations during these events aimed to cement grower knowledge, increase likelihood of adoption, highlight a need to change, develop decision making skills supportive of effective change, and showcase information that could be used to support improved management practices. Grower participation on the day in discussion of results, outcomes and potential application was encouraged and facilitated by the consultant and the national coordinator with the aim of:

- encouraging all growers to think about the information presented during the day
- raising the awareness and relevance of the information to their own orchards and situations
- understanding how the information could be incorporated into their own management regimes

Feedback on the effectiveness of these field days was obtained from growers present at each extension day, either via a verbal short survey and discussion session or through a more formal approach using survey sheets in 2014 and 2016.

Participation of growers, state association and the national body (CGA) and other stakeholders was critical to the success of the participatory method. The relevance of specific technical information changed depending on circumstances for the region, (e.g. local climatic conditions, economic/market conditions), so the program for the extension events was flexible and adaptive to State and grower needs.

Coordination and function of the program

Regional Coordination

In each state, the local regional coordinator (grower) was the first contact person for that state (New South Wales: Tom Eastlake, Fiona Hall, Kate Noller; Victoria: Steve Chapman, Alison Jones, Fiona Pogue; South Australia: Andy Flavell, Nick

Noske, Darren Gratez; Tasmania: Peter Morrison, Phil Pyke, Ian Cover; Western Australia: George and Kathy Grozotis). The state based regional coordinator liaised between local industry members, their State association and other key industry/state department representatives. The role of the regional coordinator was two-fold:

a) to nominate key industry priorities for their state based on discussions and feedback
b) to help facilitate the extension event for their state each year

In states with several major growing regions, several regional coordinators assisted the national coordinator. Their responsibilities included locating venues, publicizing the event, and coordinating attendance (catering, provision of fact sheets, determining site and setting up location, feedback and evaluation of the day, and information provided).

National coordination

The national program coordinator (Dr Penny Measham from August 2013 – December 2015; Dr Dugald Close from September 2015 - April 2016) Mr Robert Nissen from April 2016 - May 2017) liaised with the regional coordinators, state representative, cherry industry research and development (R&D) committee, CGA representatives, Horticulture Innovation Australia Limited (HIA) and TIA management (Dr Dugald Close) on program activities. The national program coordinator was responsible for guiding the extension activities based on consultation with regional coordinators, state and national CGA representatives and consultant to ensure state and national industry priorities were represented in the planning of extension activities. It was also the responsibility of the National program coordinator to evaluate the program development.

Proceedings and Events

Events were scheduled at the same time each year to provide predictability and encourage these events to become entrenched in the grower participant's calendars, but also having a flexible program that is collaborative and can meet local needs provided the greatest benefit to industry. Hence the extension activities, need to be highly relevant and have content that meets the needs of all regions across Australia as well as content to address local issues. As local, regional, state and national issues change each season and year, the process that was utilized by the NCDP enabled it to be highly flexible and agile to meet the needs of the industry and its growers. The original project schedule is presented in Appendix A and was used as a guide for the NCDP reference group. However, due to grower and industry issues that appeared during the course of the project, changes were made to scheduled activities to accommodate the differences in States, growing regions and grower requests.

Outputs

National Cherry Development Program (NCDP) Establishment of Content and Requirements.

Changing national, state and grower priorities altered the project content, methodology and requirements. Project plans were changed and new content and requirements were established in partnership with industry. These were: 1) each state had different means of communication and therefore regional coordinators would be responsible for publication and feedback on events. 2) program feedback would be via both informal and formal channels from each state. 3) A clear process for setting project priorities was established in consultation with state cherry growers. This involved program members (reference group) discussing key priorities with its industry members, they then provide a list of potential topics back to the NCDP member's for consideration. 4) These potential topics would then be matched with current domestic and international research being conducted or completed. 5) Information topics and the agenda would then be provided to state and regional coordinators to publicize the events, topics, location and venues for industry members to attend. The scheduled project activities were modified and amended to accommodate these changes (See Appendix A for original project scheduled activities).

As the project progressed during the first twelve months a change in state representatives occurred and problems with lack of communication and grower consultation was raised by a number of growers in NSW. These issues caused a delay in some aspects of the program. Extra discussion and communications were undertaken by the program coordinator to keep each representative in each State at the same information level. Circulation of priorities and resetting priorities and information flows to all members regarding those priorities resulted in alternative communication channels for grower feedback, via the state representatives. Furthermore, the email system used at that time did not provide the information to all members, hence it was decided by the NCDP reference group to distribute updates and information via the CGA network as well.

NCDP Consultant Engagement

Hiring of a consultant to conduct orchard and grower participation events was a major component of the NCDP. In July 2013, the evaluation criteria and statement of requirements for the consultant was developed by TIA and University of Tasmania (UTAS) (See Appendix B). The advertisement for a consultant was placed in a national newspaper and on the TIA website in December 2013, with applications due by the 10th January 2014. A summary of the applications with recommendations were forwarded for consideration by the NCDP coordinator and national and state representatives. A meeting held in late January 2014 that resulted in clear preference for one candidate. All referees confirmed this choice and in early February 2014, and Mr. Peter Morrison, an agronomists with 19 years of experience was offered the consultancy. Mr Morrison accepted the consultancy and was introduced to the program and reference group members in the March 2014 meeting. In addition, a program update sheet was distributed by the NCDP and CGA, introducing Mr Morrison to the national cherry industry members (See Appendix B).

NCDP Reference Group Consultation - Industry Topics and Priority Setting Meetings

Several NCDP reference group (steering committee) meetings were held each year via teleconferencing. Reference committee members were provided with free dial in number and pass code. These teleconference meetings were between CGA, state representatives and grower reference committee members. At these meetings discussions were held on industry priorities, topics and the timing of training workshops and road shows events for each state. From these discussions, agreements are reached between all reference committee members. The minutes were circulated to all reference group members for confirmation of agreements. The NCDP coordinator in consultation with the CGA, state representatives and the reference group, then organised the events, including location, equipment and facilities, the topics and their content (handouts, factsheets and presentations) and program. The NCDP and research agency (TIA) then utilized their extensive networks and contacts to invite guest (international or Australian experts, consultants, and growers), covered speaker's travel and accommodation etc., and assisted with presentation topics and content. Minutes of these teleconferences from 2013 to 2017 are available upon request for TIA. Road Show outputs endorsed by the reference committee and arranged by the NCDP are listed below. In addition a list of outputs from workshops, training, and information sessions are provided below under road show events with factsheets and information provided to grower attendees in Appendix G. Appendix G also includes Fact Sheets for Grower Training on Pest and Diseases.

NCDP Mid-Project review

A mid-term project review was conducted by Horticulture Innovation Australia Limited (Hort Innovation) (Alison Anderson, Portfolio Manager-Industry Development). The review included a teleconference and review of NCDP documents. The teleconference was conducted on the 23rd of March 2015. This included individuals involved in the project; Penny Measham (National Coordinator), Simon Boughey (NCDP committee and CEO of Cherry Growers Australia) Dugald Close (NCDP Committee member R&D committee representative), Stuart Burgess (Hort Innovation Industry Services Manager), Geoff Clark (Cherry Grower, Young, NSW) and Steve Chapman (Cherry Grower, Yarra Valley, Victoria). This resulted in a confidential report on the National Cherry Development Program which recommended the project continue as per the project plan, as findings showed the project to be of high value to the cherry industry. The report identified that additional communication channels and key stakeholders needed to be found in each growing region, State agency staff, consultants and rural suppliers should be included. The project has capitalised on its strengths and harnessed opportunities within the project scope and budget as indicated by the review. The project team have applied the recommendations and integrated these into the project post review.

Outputs on all road show presentations were placed on the TIA, Perennial Horticulture Centre Website under Fact Sheets & Tools which is accessible to the public. Project fact sheets and information documents have also been placed on the CGA websites (this website is accessible to all levy-paying cherry growers) and on the Fruit Growers Tasmania website, with linkages to the other websites. Links to presentations and additional information on other websites that contain cherry information are also provided. In addition presentations, fact sheets and information papers and articles were emailed to the reference group members for distribution to other growers in their respective regions. Several articles were published in the Cherry Growers Australia Newsletter and now in the Cherry Magazine by working collaborating with CORETEXT, the Hort Innovation approved communications group. The NCDP has collaborated with CORETEXT by providing regular updates on the NCDP. In each region, rural suppliers were invited to attend and several different firms have attended (E.E. Muir & Sons, CRT Rural Supplies, Roberts Rural Supplies, Landmark Rural Supplies); TAFE and University Students and Lecturers, as well as representatives from various state government agencies in Vic, NSW, SA and WA have also attended. Other programs such as the Hort Innovation Queensland fruit fly (Qfly) Area Wide Management (AWM) and Sterile Insect Technique (SIT) have collaborated and attended the NCDP events. These linkage have been fostered by the NCDP program to build a network system capable of delivering high quality cherry information to cherry growers.

Road Show Events and Project Activities Undertaken

2013 Activities and outputs

2013 NCDP Road Show
The July 2013 road show visited five states Vic, NSW, SA WA and Tas with one research and one other presenter. The NCDP program (Appendix E) was presented to levy-payers and feedback sought on topic priorities and activities through both informal and formal communication processes.

- In NSW the NCDP was presented at the national conference in Canberra August 5-8-2013.

- In South Australia Dr Penny Measham presented on cracking and fruit set and Dr Karen Barry presented on pre-harvest rot in sweet cherry (See Appendix F) and Dr Darren Gratez presented an update on the breeding program.
- In Victoria Dr Penny Measham presented on Cherries and Chill.
- In Tasmania the NCDP was presented to all cherry growers during a seminar night.
- In Western Australia Dr Penny Measham spoke on fruit set, exports and chilling and Mr Peter Morrison on orchard pruning and training systems.

2014 Activities and outputs

2014 NCDP Road Show

Planned activities for the 2014 state events were developed with the national coordinator and the NCDP consultant Mr. Peter Morrison. This process required considerable time investment by the NCDP coordinator to engage and obtain responses from industry partners. Further investment was made to coordinate with other industry activities and new developments which resulted in providing highly accurate and relevant information to growers.

Program activities were developed for each state, apart from WA. These activities were similar in nature for Vic, SA, NSW and TAS (See Table 1 below). The date and venues were developed between the individual state representatives and the national coordinating reference group members. A different set of activities was developed for WA and all road show events were conducted May-July 2014. The NCDP road show visited five states (Vic, NSW, SA, Tas, and WA) in 2014.

Table 1. Planned activities for 2014.

Time	Activity	Facilitator
10:00-11:00	China pest monitoring workshop (or quality R&D if no export)	Penny Measham
11:00-12:30	Pest and disease monitoring/spray records/MRL's workshop	Peter Morrison
12:30-13:30	Options; 1. Quality R&D 2. Biosecurity expert 3. Continuation of monitoring workshop	Peter Morrison or Guest
13:30-14:00	Lunch	
14:00-16:00	Field/Orchard walk • Monitoring requirements • Sampling techniques • Orchard hygiene /spraying for rot management	Peter Morrison

Pest and disease monitoring, updated spray programs to meet export protocols.

Growers in all five states were asked if they wished to participate in developing their export readiness. WA and SA growers did not wish to participate in the export readiness program. The export readiness program conducted by the NCDP included the China pest monitoring workshop, pest and disease monitoring and spray program for Vic, TAS and NSW. This required the development of factsheets, monitoring guide and spray program for each participating state. The NCDP coordinator and consultant reviewed recent changes in export destination maximum residue limits and updated the export interval guide and developed a recommended spray program to meet export protocols. In addition, 32 fact Sheets were produced and provided to growers during the training sessions. These fact sheets are available in Appendix D, and the export interval monitoring guide and IPDM calendar for cherries is in Appendix G.

Priority setting for the National Cherry Development Program

The objective of the NCDP is to facilitate communication, extension and education for the cherry industry. The NCDP coordinator in conjunction with HORT INNOVATION and CGA developed a questionnaire and conducted a survey of cherry growers in NSW, Vic and Tas. The aim of this questionnaire was to obtain feedback on the performance of the program and acquire grower input into the development of future events. The questionnaire form was provided to cherry growers attending the road show events in 2014 (See Appendix H). The output from the response to the questionnaire was used to develop future NCDP grower information sessions and training workshops.

NCDP International guest speakers

CGA, state representative bodies and leading growers are very conscious of the underlying assumptions that all fruit produced is of export quality. This was raised during NCDP priority setting activities. Understanding how to produce fruit of export quality is a major concern of the CGA and a priority. As an output of this priority the NCPD focused grower attention on producing export quality fruit. Starting at the point where quality fruit is created (in the field), the NCDP hosted Professor Lynn Long and Marlene Long from Oregon State University USA to provide growers with the latest USA research on “Optimising Fruit Quality”. Prof Lynn Long Spoke on Pruning Trees and on producing Productive Trees and Standard Rootstocks. Grower discussions also included topics on cultivar/rootstock interactions. Marlene Long spoke on “best harvest and postharvest handling practices”. The road show team visited NSW, Vic and Tas. SA declined this opportunity and the road show, hence a roadshow was developed for SA that focused on more formal presentations, orchard walks and demonstrations.

Communications and coordination of activities

Representatives from NSW were concerned by the availability and change in CGA presidency. In addition, many SA growers were not willing to participate, due to the poor season experienced in 2013-2014. To overcome these issues it has become standard practice to increase the reference group to include at least 2 members from each state where possible. This provided growers with greater presence and representation on the NCDP reference committee. The time and effort put into the export-readiness was above and beyond the time allocated for the program. However it was deemed important work to be undertaken, and there were considerable time limits to achieving good outcomes, which this program did achieve.

2015 Activities and outputs

2015 NCDP Road Show

After consultations with each respective state’s growers and associations the agreement outputs of the NCDP were aligned to meet the national CGA focus. The focus should remain on market access and Biosecurity Manual Production. In addition, states also identified specific priorities regarding fruit production (Little Cherry Virus, postharvest guidelines and fruit fly). Western Australia raised their concerns around winter chill and requested advice on the best response to lack of chill. The NCDP conducted several activities in 2015. As indicated above, Prof Lynn Long presentation was presented jointly by the national coordinator and consultant in SA on the 20th March, 2015. Andrew Jessup also agreed to present recent work on Brown Sugar Flotation method to access fruit fly infestation.

Numerous submissions from cherry growing regions across Australia were received by the NCDP to assist with activities that are normally performed by state associations. This evolved due to insecurity felt by state associations and funding. However, many of these events could not be supported or funded by the NCDP in the current form or budget. NCDP project team members contributed well above their allotted allocations for the running of the program in 2015. In addition, SA and NSW growers indicated that the NCDP is a high priority for them to obtain crucial information on improving their production and marketing systems. In 2015 the program had obtained good traction and support from growers.

Market access priorities were well addressed through the delivery of registered crop monitoring training. Training was conducted in NSW, Vic, SA, WA and Tas. Dr Penny Measham and consultant Peter Morrison conducted the training sessions according to the revised industry standard (See Appendix I). All support material was updated, including the IPDM chapter in the cherry export manual and the list of registered chemicals updated; re maximum residue limits and export interval guides for 11 export destinations; the sustainable spray guides for 11 export destinations; and the 2015 IPDM calendar. The training is a compulsory part of the China protocol and Dr Penny Measham has liaised with both DAWR and Tocal College (NSW) to develop the training package into an online delivery system. This was piloted 2016. Dr Penny Measham presented at the Victorian Cherry Growers Association Conference on research in flowers to fruit; early fruit formation and late flower quality (See Appendix J).

Considerable feedback was received on NCDP priorities through informal and formal communication from growers, CGA, state representatives and individual growers. A list of NCDP outputs and activities conducted and NCDP presenters for 2015 are presented below. Planned activities for the NCDP to consider for 2016 are also presented below.

NCDP Outputs for 2015

- Measham, PF and Cover, IP and Rix, KD and Bound, SA, “Cytolin and nose cracking”, *Victorian Cherry Association Conference 2015*, Healesville, Australia (2015)
- Measham, PF, “TIA: Cherry fruit quality”, *Victorian Cherry Association Field Day*, Tatura, Australia (2015)
- Reader, J. “Industry data Collection” *Victorian Cherry Association Field Day*, Tatura, Australia (2015)
- Measham, PF, “TIA: Cherry fruit quality”, *South Australia Cherry Growers Association pre-season seminar night*, Lenswood, Australia (2015)
- Reader, J. “Industry data Collection” *South Australia Cherry Growers Association pre-season seminar night*, Lenswood, Australia (2015)
- CY12000 factsheet; Cytolin and nose cracking
- 2015 IPDM Calendar
- 2015 crop monitoring standard
- 2015 IPDM chapter, Cherry export manual
- 2015 The National Development Program grower update fact sheet

NCDP Activities for 2015

- Preparation (monitoring and evaluation report) for mid-project review
- Review and development of 2015 MRL and export interval guides (EIG)
- Review of registered chemicals available in 2015
- Review and Development of Spray guides for export to 11 countries (3 more than 2014); China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, UK/EU, USA
- Review and update of Export manual IPM chapter
- Evaluation of crop monitoring training from 2014
- Review and development of 2015 crop monitoring training package
- Review and Development of 2015 IPDM calendar
- Delivery of 2015 crop monitoring training; 5 face-to-face workshops in five states (NSW, VIC, TAS, SA and WA), 2 teleconference training sessions
- Printing of Good Agricultural Practice package (training, pest and diseases fact sheets, spray guide, EIG, IPM chapter) for distribution with registered crop monitor certification
- Development of new online training system with Tocal college (NSW)
- Contribution to CGA Biosecurity Manual Protocols team and activities

- R&D presentation to VCA conference
- Chill and Dormancy field day and presentations in WA
- Fruit quality and pruning field day and presentations in SA
- Postharvest and firmness presentations in SA
- Fruit quality and Firmness presentations in VIC
- Presentations/discussion re collection and use of industry data (TAS, VIC, NSW*, SA)

NCDP Presenters for 2015

- Peter Morrison
- Penny Measham
- Jesse Reader
- Susie Murphy-White
- Nick Owens

NCDP List for discussion and consideration for setting 2016 activity priorities

- R&D - Current HORT INNOVATION projects;
- CY12002 Fruit quality and maximised nutrient availability
- CY12000 Reducing the Impact of late season rainfall
- CY12010 Comparing the performance of new cherry rootstock
- CY13001 management of preharvest rot
- MT12001 SPLAT Culture management of Qfly
- SITplus R&D projects
    - Adaptive Area wide management of Qfly using SIT

NCDP R&D - Other relevant projects

- Adaptive Area wide management of Qfly using SIT
- Crossing the threshold; adaptation tipping points for fruit trees
- ARC Training centre for Innovative Horticultural products (extending cherry shelf-life project)
- The bee doctor; bees delivering bio-control fungicides
- Industry data collection pilot program
- Continued market access contribution through BMP and IPM work, systems approach training

2016 Activities

Dr Dugald Close attended the 2016 Victorian Cherry Conference. Many of the issues raised by growers attending this conference reinforced the issues raised by state representatives across Australia (stem retention, crop loading, fruit set and Queensland Fruit Fly (QFF)). Following the resignation of Dr Penny Measham in September 2015 and prior to appointment of her replacement, Dr Dugald Close held a consultation meeting with the project reference committee. The outcome of consultation with the reference group were:

- Stem retention issues
- Over cropping, crop loading and fruit size
- Cultivars (increased understanding of genotype x environment interactions)
- Pollination, flowering, fruit set and shy bearing
- Fruit Cracking
- Environmental Conditions (water stress, hot weather, unwanted rainfall events – rain-covers)
- Queensland Fruit Fly (QFF) NSW and market access

Mr Robert (Bob) Nissen was appointed by TIA to coordinate the National Cherry Development Program. Mr Nissen moved from Queensland to TIA and commenced work on the 21st April 2016. From issues raised by Cherry Industry growers at conferences, Mr Nissen liaised with state representatives, and individual growers. These outcomes were:

- There was unanimous support for development of a Future Cherries Program, similar to the Future Orchards programme in apples. The consultations indicated that a program based on the Future Orchards program will provide growers with practical hands on education to increase fruit quality, productivity and business acumen. This will assist cherry growers to further improve their own orchards. Mr Nissen developed a strategy under which a future NCDP programme may operate. The suggested strategy was presented and discussed with growers during the NCDP 2016 road show events held in NSW, Vic, SA and Tas (See Appendix L).
- Cultivar evaluations to determine industry benchmarks for yield, quality, pack-out and development of industry decision support system. With the release and planting of new cultivars there is a critical need for data collection to provide credible industry statistics. At present no reliable statistics are available from data collected or information collated from growers across the Australian cherry industry. The predicted industry expansion and increased production, has highlighted a crucial and real need to develop a system to capture industry statistics. Key issues highlighted by industry growers and leaders, and a quick analysis of industry documents indicate an urgent need for the cherry industry to develop a central platform to capture industry data. This solution will assist the industry to determine industry size, value, yield efficiency and fruit quality attributes suited to domestic and international markets.
- Stem retention (Stem off) was a critical issue across all Australia States during the 2015-2016 fruiting season. In SA, cherry growers experienced an extremely dry season. Many growers indicated the drought conditions affected cherry development and fruit quality. Major supermarkets in Australia require cherries from their suppliers with their stems on. The Asia Markets also require cherries with green stems attached. Green stems are a sign of freshness in Asia. A literature search found there is considerable evidence in cherries to indicate there is substantial cross talk between plant carbohydrate status, plant hormones and environmental factors that contribute to cherries shedding their stems and fruit. Some reference group members recommended:
  - An extensive literature review be undertaken on stem retention.
  - Projects developed that examine the aspects as to why cherries shed their stems. The projects should determine how to control the various environmental factors and application of plant bio-regulators to understand and stop fruit drop and improve stem retention in cherries.
- Growers indicated that during the 2015-2016 cropping season, crop loading issues substantially impacted on their business. SA growers experienced high fruit set and an extremely dry season. In the Adelaide Hills area, many growers indicated that drought affected their fruit size. Growers were trying to determine the best crop load levels to set on their trees during these drought conditions. Many growers in SA surmised that pruning, irrigation and fruit development have a major effect on crop load levels.
- Many growers are now implementing artificial crop protection structures to enhance fruit quality. Bird netting is used by most cherry growers in Australia. In addition, structures to mitigate against unwanted rain fall events are now being constructed over orchards. Growers hope to negate the effects of rainfall events: fruit splitting, soft fruit and favourable conditions for disease incursions. Cravo and Voen roof houses are two systems presently being installed by cherry growers in Tasmania. In Australia very little information is available on how cherry trees will function and perform, once placed in protective structures. Trials are needed to compare the effects on:
  - tree architecture and canopy management practices
  - phenological patterns:
    - vegetative growth and fruit set, growth and development
    - fruit quality and marketability of fruit
    - starch reserves
    - water use
    - pest and disease patterns
    - economic impacts on management practices both pre- and post-harvest

- From these consultations with growers and reference group members, the following topics were selected to be discussed at the NCDP Road Shows:
    - Pollination and fruit set
    - Crop loading and mechanical pruning
    - Stem retention (stem off)
    - Queensland Fruit Fly
- Professor Matthew Whiting was contacted and engaged to provide the latest cherry research information from the USA on pollination and fruit set, crop loading and mechanical pruning; and Dr Penny Measham to discuss QFF. Mr Nissen also asked the contractor Mr Peter Morrison to develop the field discussion sessions for the road show events.
- Five NCDP 2016 road show events were organized for NSW (2), SA (1), Vic (1) and TAS (1). Details on the road show events for each site and state are provided in Appendix C.
    - Due to Dr Whiting's commitments, timing and cost constraints, the road show could not be taken to WA or Queensland.
    - The research conducted by Dr Whiting at Washington State University matched the issues raised by individual Australian cherry growers and the NCDP reference group.
    - As NSW is one of the top cherry producing states, and the road show was scheduled during peak flowering, it was decided to hold two road show events, one at Young and the second at Orange, to enable growers the opportunity to hear Dr Whiting's presentations and obtain new information on cherry production.
    - Cherry industry advocates for WA were difficult to contact. However, contact was eventually established with Mr George and Mrs Kathy Crozotis, Cherry Lanes Fields, Manjimup, WA.
- An updated list of priorities based on Cherry Industry issues for 2016 was provided and distributed to all coordinators (See Appendix K). This list was circulated to the NCDP reference group members on 8 /11/2016. Reference group members are still developing the priority ranking for the issues identified by cherry growers in 2016.
- and the following articles were developed and sent to CORETEXT for publication in Cherry Industry Grower Magazine.
    - Dr Penny Measham – Reducing the impact of late season rainfall on fruit cracking, Ian Lewis editorial, Spring, 2016, Issue 1, p. 9.
    - Robert Nissen – "National Cherry Development Program Update", Ian Lewis editorial, Spring, 2016, Issue 1, p. 11.
    - Assos Prof. Dugald Close, Dr Sally Bound, Dr Joanna Jones and Dr Nigel Swarts – "The variability factor", Spring, 2016, Issue 1, pp. 16-18 .
    - Organised with Editor Tom Bicknell, CORETEXT a video on "Crop variability in cherries"
    - Robert Nissen - "National Cherry Development Program Update", Ian Lewis editorial, Summer, 2016-2017, Issue 2, p. 9.
    - Robert Nissen - "National Cherry Development Program Update", Ian Lewis editorial, Autumn, 2017, Issue 3, p. in press.

2016 NCDP Road Show

In consultation cherry growers across Australia, the NCDP reference group identified six topics (cultivars, pollination, fruit set, stem retention, crop loading, Queensland Fruit Fly (QFF) - NSW), for the 2016 road show event. Dr Whiting was the guest speaker, but was only available to participate in the NCDP Road Shows during the first or second week of October 2016. This coincided with suggestions put forward by Victoria and NSW representatives. At the beginning of each road show event Mr Nissen made it clear to all grower participants that this project is funded by HORT

INNOVATION and grower levies; thanking them for support of this project. The road show in Young, in-field discussion and grower dinner was attended by, HORT INNOVATION Relationship Manager, Mr Mark Spees and Marketing Manager, Mrs Dianne Phan.

Dr Whiting presented new information collected in the last few years on cherry harvesting, cherry orchards efficiency, cherry pollination, fruit set, and fruit size. A series of road show events were held from 3rd October – 10th October in Victoria (Vic), New South Wales (NSW), South Australia (SA) and Tasmania (TAS). While the timing of the road show was not ideal (during flowering and fruit set for Australian Cherry Growers), it must be stressed that this was the only period the services of Dr Whiting could be acquired.

The road show presentations by Dr Whiting are provided in Appendix L, along with Mr Bob Nissen presentation on suggested strategies for the future of NCDP. At the road show events in Vic, NSW, SA and TAS a questionnaire was provided to participants; on the importance of the NCDP to cherry growers; how the NCDP should be organised to deliver on grower issues; and what priorities are crucial to running a successful cherry enterprise. Results are presented below under the NCDP evaluation.

NCDP Evaluation

Grower recruitment for this survey was based on cherry growers who attended the NCDP Roadshows events at Old Beach, Tasmania; Young and Orange New South Wales; Lenswood, South Australia; Yarra Valley Victoria. The questionnaire recruitment criteria was: only cherry growers were eligible:-. 1) growers had to be a member of CGA; 2) growers had to own/operate a farm, and have produced and marketed fruit either domestically or internationally. Participation was completely voluntary and questionnaires did not ask or obtain any personal data. Only industry registered cherry grower responses were obtained and analysed. Local agronomic advisors, local Technical and Further Education (TAFE) and University students and associated industry personnel who attended the NCDP road show events did not complete the questionnaire. During the project, 122 attendees from the 2014 road show event, or approximately 61% of grower respondent's returned questionnaires for analysis. Of the 181 participants who attended the 2016 road show event, held across four states and five locations, 70 questionnaires were returned for evaluation. Only registered levy paying cherry grower opinions were sought. Mr Robert (Bob) Nissen has collated, summarised and analysed the questionnaire data and produced a paper that will be published in Acta Horticulturae. Ethics and publishing approval have been sought from the University of Tasmania and Horticulture Innovation Australia.

2017 Activities and outcomes

Two NCDP reference group meetings were held in the first half of 2017.

A teleconference meeting was held on the 14th of March to discuss the NCDP proposal to travel to WA and conduct a road show for the WA cherry growers.
A suggestion put forward during the teleconference was the need for a benchmarking project as part of the NCDP. This project would support the Australian Cherry Industry Strategic Investment Plan (SIP) and the variability in cherry fruit quality produced by Australian cherry growers. In addition, suggestions were put forward for potential new projects under the NCDP. The suggestions were:

- New NCDP model along the lines of Future Orchards®, but within the budget of the CGA. Mr Bob Nissen suggested registering the new NCDP as Cherry Innovations and other reference group members suggested Cherry Innovation Australia. It was also suggested that close links with the preferred cherry communications group CORETEXT be maintained.
- Industry predictors to estimate chill units
- Industry predictor (forecasting tool) for pollination, flowering, fruit set and fruit growth

- Industry benchmarking and agribusiness economics
- Revamp the Australian Cherry Production guide, this should include
    - Chill models
    - Pollination
    - Cherry Training Systems
    - Agribusiness, variable costs, fixed costs, gross margin analysis etc.
- This was to be the last meeting before the project ends. However, the reference group members decided to allow a little time for the reference group members to consult with growers on new ideas for the NCDP. A new meeting was scheduled approximately one month after this meeting and after the Victorian Cherry Growers Conference.

NCDP reference group meeting 13th May 2017.

Suggestions for components to include in a potential new project that can be linked together to form part of a New NCDP (Cherry Innovations Australia (CIA) Program. Research, extension and communication program project that has a national focus and resolves state and regional issues and priorities. The program will create events

2017 NCDP Road Show

A road show event was held in WA on the 5th of April 2017 at George and Kathy Crozotis, Cherry Lanes Orchard, Manjimup. Dr Whiting information on pollination, fruit set and fruit retention and orchard design, mechanical pruning and harvesting was aligned to Australian conditions and presented. Approximately 17 WA growers attended the event. One grower travelled 7 hours to be at the event while another travelled 4 hours. Dr Dugald Close presented new information on pollination of cherries including information from Dr Whiting. New information was presented in addition to the presentation provided to the cherry growing regions in the eastern states. Mr Bob Nissen presented Australian information on future cherry orchards including information from Dr Whiting's talk on cherry orchards of the future. Mr Nissen also included new information on what further cherry orchards in Australia may look like. Talks presented in WA by Dr Close and Mr Bob Nissen are included in Appendix M. Consultant Mr Peter Morrison conducted the in-field grower discussion session on orchard management. Peter provided information on nutrition, rootstocks, cultivars, growth regulators, pruning and training during the grower discussion session. Mr Peter Morrison also presented information on Regalis® and Zinc application to increase first leaf size for fruit retention and improved fruit size and quality. Further in-field grower discussions on tree architecture, pruning and training, yields and fruit quality were well received by growers and good discussion resulted in growers wanting more information.

Documents produced and collaboration research project documents provided by the NCDP

The NCDP has provided information to the reference group members, state representatives and individual cherry growers. Some information has come from other projects, but the NCDP has been used as a vehicle to highlight this research to cherry industry growers in combination with releases from the individual project researchers. Due to the vast number of documents, links to these documents provided to the NCDP reference group committee members and growers, are listed below. The documents are highly accessible to the general public and easily found on the TIA website under Fact Sheets and Tools, Cherries at the University of Tasmania website.

Dr Karen Barry – preharvest rot in sweet cherry

- http://www.utas.edu.au/__data/assets/pdf_file/0004/693904/Cherry-rots_2015_final3-040615.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0011/909182/Cherry-rot-ID-guide_final_2016.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0009/967338/Cherry-rot-risk-tool-user-guide_April-2017.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0010/367471/Brown-rot.pdf

Dr Penny Measham – Cherry Pest and Disease management

- http://www.utas.edu.au/__data/assets/pdf_file/0007/678940/IPM2014_Final.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0007/754117/IPDM2015.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0005/754097/IPDM-BINDER-pest-sheets.pdf
-

Dr Penny Measham and Dr Rebecca Darbyshire – Crossing the threshold: climate and cherries

- http://www.utas.edu.au/__data/assets/pdf_file/0003/754050/FS_DoA_dormancy.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0007/754090/FS-2013_C5-CY12013_chill_budburst_cherries.pdf

Dr Penny Measham and Mr Robert Nissen – National Cherry Development Program

- http://www.utas.edu.au/__data/assets/pdf_file/0005/563540/2014-National-cherry-development-program.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0007/754045/Fact-Sheet-NDPMay2015_mb.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0007/966121/Cherry-Road-Show-2017.pdf (

Ass Prof Matthew Whiting – Washington State University National Cherry Development Program, pollination, fruit set and mechanical harvesting and pruning.

- http://www.utas.edu.au/__data/assets/pdf_file/0008/909845/TassieWhiting_I.compressed.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0008/909845/TassieWhiting_I.compressed.pdf

Dr Sally Bound – Soil amendments and microbes to improve cherry fruit quality

- http://www.utas.edu.au/__data/assets/pdf_file/0006/563541/2014-Can-improved-soil-biology-increase-nutrient-availability-.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0009/563544/2014-Tree-nutrient-availability-and-fruit-quality-in-sweet-cherry-and-apple.pdf

Dr Penny Measham – the impact of late season rainfall and optimising fruit set, crop load, and fruit nutrition

- http://www.utas.edu.au/__data/assets/pdf_file/0007/754297/Fact-Sheet-Reducing-the-impact-of-late-season-rainfall_Cytolin.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0004/563539/2014-Reducing-the-impact-of-late-season-rainfall-giving-fruit-a-helping-hand.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0008/754262/Late-season-rain_calcium_MB1.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0008/409238/Measham-Thailand-poster-A1.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0007/563542/2014-Reducing-the-impact-of-late-season-rainfall-fruit-water-uptake.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0003/563538/2014-Cherry-shedding-under-the-microscope.pdf
- http://www.utas.edu.au/tia/centres/perennial-horticulture-centre/fact-sheets-and-tools/fact-sheets-and-tools
- http://www.utas.edu.au/__data/assets/pdf_file/0006/415815/Poster-Fruitlet-abcission.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0018/409221/Fact-Sheet-yield-and-quality.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0004/367465/Cherry-splitting-poster.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0009/367479/Improving-marketing-yield-and-reducting-cracking.pdf
- http://www.utas.edu.au/__data/assets/pdf_file/0007/409237/Measham-spain-poster-2013.pdf
- Dr Dugald Close - http://www.utas.edu.au/__data/assets/pdf_file/0006/367458/Cherry-yield-security-and-fruit-quality.pdf

- Dr Nigel Swartz - http://www.utas.edu.au/__data/assets/pdf_file/0003/367464/Cherry-fertigation.pdf
- Hend Mohammed - http://www.utas.edu.au/__data/assets/pdf_file/0003/563547/2014-Arbuscular-mycorrhiza-AM-and-sweet-cherry.pdf

Outcomes

The project started late in the 2013 financial year. At the start of the project in 2013 concerns raised by growers and state bodies about the project were quickly solved. This was due to the extra effort and time invested by TIA and the national coordinator to take up the concerns from growers and the state bodies to ensure their engagement and obtaining their full support. The NCDP program was presented to levy-payers in NSW at the national conference in Canberra August 5th August, 2013 (See Appendix B). This resulted in a review of expectations and direction of the program. Input was then sought from all states as to the immediate needs of cherry growers. New approaches were then put forward and previous priorities revised a shown in Appendix A. The priorities suggested from consultations were then acted upon by the NCDP. From these priorities the NCDP made a significant contribution, by training Australian cherry growers to the CGA industry standard for export of cherries to China. The consultant, Mr Peter Morrison, who was engaged by the project, also assisted the NCDP and proved to be highly valuable to the project for his expertise in dealing with growers, knowledge on pest and diseases, their control methods and chemicals. Crop monitoring guides, IPDM Calenders, Export chemical usage and MRL guides produced and reviewed each year and pest and disease fact sheets are used by industry growers for export of cherries. Greater than 40 cherry growers were trained in the good agricultural practice (GAP) of the biosecurity management program. Only one orchard was rejected for non-compliance. The support and solutions provided by the collaborating agencies through the NCDP with CGA, state bodies and regional grower groups enabled Australian cherries to be exported to China. As a result of the NCDP training program in 2014, greater than 120 tonnes of cherries were exported from mainland Australia to China. The NCDP has continued to provide support each year to the Orchard biosecurity manual upgrades and consultation with growers, Federal Government Statuary Authorities and State Government Agencies and industry consultants.

The mid-term review by Horticulture Innovation Australia indicated the project was of high value to the cherry industry and it should continue as per the Deed of Agreement 2014-18. Outcomes of the review showed that NCDP industry engagement was increasing and the project start to use additional channels of communication and key stakeholders in each growing region. This included State Government staff, consultants and rural suppliers. The NCDP carried out road show events with assistance from Kevin Dodds and Adam Coleman, Rebecca Darbyshire (NSW Govt.), Charlotte Brunt (Vic Consultant), Darren Graetz (SA Govt.), Dianna Fisher (WA Govt.), and Rural Agencies (Muir & Sons, CRT Rural Supplies, Roberts and Landmark). These have all attended and been involved in recent NCDP road show events. As requested by the mid-term review, a feedback survey was undertaken on the effectiveness of the NCDP and changes to farming practices as a result of the NCDP. In addition, all midterm review recommendations were implemented by the NCDP. The outputs from the questionnaire addressed the mid-term recommendations. This questionnaire was conducted during the 2016 road show events. A paper summarising these outcomes has been developed and will be presented at the ISHS international cherry symposium in 2017 and published in Acta Horticulturae.

Highly successful road shows were also conducted as part of the NCDP. Road Show events were conducted in 2013, 2014, 2015, 2016 and 2017. International cherry experts provided information on the latest research from the USA (Professor Lynn Long (Horticulturist) and Mrs Marlene Long (Postharvest specialists) from Oregon State University, Associate Professor Matthew Whiting from Washington State University). Australian cherry experts, Dr Karen Barry, Dr Darren Graetz, Dr Penny Measham, Dr Dugald Close, Dr Nigel Swarts and leading growers Guy Roth, Craig Stubs, Stuart Walton, Al Turnbull, Sam Riggall, Kathy and George and Kathy Grozotis, Chris and Tony Hall, Cliff, Glenn and Stephen Riseborough, Tom Eastlake, Fiona Hall, Nick Noski, Andy Flavell, Nic Hansen and many other growers also spoke at the NCDP road show events. In addition several other growers have made significant contributions, either as a NCDP reference group member or provided feedback and inputs into the NCDP. Special mention go to Alison Jones, Fiona Hall, Steve and John Chapman, Fiona Pogue, Kate Noller, Phyl Pike, Andrew Hall, Mark Salter, Nick Owens, Howard Hansen and Tim Reid. Road show events have been well patronised by growers. For example, in 2016 the NCDP road show had approximately 180 attendees from four states, Vic, NSW, SA and TAS.

NCDP Outcomes. In the last year of the NCDP, over 181 participants attended the road show events held across four states and five locations with 70 registered cherry grower questionnaires were received for evaluation. On a ranking system of 0-10 (0 “least agree” and 10 “highly agree”), approximately 84% of growers indicated this road show ranked from 7 to 10 as highly important to Australian cherry growers. Approximately 64% of respondents ranked their level of satisfaction with the NCDP from 7 to 10. Analysis showed a positive association between the satisfaction level of growers and the importance of the NCDP to the cherry industry. Approximately 62% of respondents indicated that they changed on farm practices due to knowledge obtained from the NCDP and 94% of cherry industry growers indicated they would participate in a similar program in the future. As growers changed on farm practices due to NCDP their satisfaction level increased by 1.564 times. There was a considerable degree of positive association between new knowledge and benefits received from the NCDP and grower satisfaction levels. Similarly, there was also some degree of positive association between NCDP usefulness and advantage obtained by the cherry grower’s business enterprises and grower satisfaction levels due to the NCDP. However, no significant association was found between grower satisfaction level and the NCDP format used to transfer information. Growers indicated they are focused on obtaining knowledge in a format that they can readily apply and incorporate into their individual enterprises.

Evaluation and discussion

The late start of the NCDP project and the need to collaborate and consult with the respective cherry industry members to set key priorities caused a delay in grower engagement and uptake of information. However, once the NCDP priorities were aligned with CGA national, state and regional priorities the NCDP increased its importance with growers and delivered grower training programs on export protocols for cherry exports to China.

The engagement of a consultant with good ability to communicate to growers and with enough experience in the cherry industry to assist in grower in-field discussions session is one aspect that needs to be carefully considered in the development of a new NCDP. This aspect has added good value to the project.

The approach by the NCDP was extremely successful in achieving it objectives. In 2014 approximately 99% of growers indicated they had learnt highly relevant new information. In 2016, as indicated above, 62% of growers reported changed on farm practices due to knowledge obtained from the NCDP. While the reported adoption rate of new technology from this project is high (62%) a 37% difference was found between learning new information (99%) and actually implementing new practice on farm (62%). This is an indicator for improvement. These findings are indicative of the grower’s comments on interpreting research findings and applying these to their enterprises. This also indicates a need to improve growers problem solving skills and simplification of research findings to ensure greater grower uptake. The association between simple, highly applicable knowledge transfer and grower satisfaction levels indicates how effective the NCDP is in assisting and working with small regional groups. The satisfaction levels of growers and usefulness and the advantage of having a NCDP for growers, indicates that multiple research and extension methods are required to deliver a broad range of information to a diverse range of growers and regions.

Whilst the initial approach of the NCDP project is a bottom up approach the project can incorporate a participatory action learning approach (PALP) with a work learn, work learn process. It is suggested that this process will build the capacity of Australian cherry growers problem solving skills and simplification of research findings to ensure grower uptake. Progressive growers take risks and learn from their mistakes. Many of these growers achieve their goals to a degree. They are mostly satisfied. However, mistakes along the way can be costly. Growers need assistance to reduce production costs and enhance their ability to meet market requirements. These factors are continually changing and growers must change or they will go out of business. Enabling activities, such as grower directed Focus Groups, Casual Workshops, and Training Workshops, all give growers the confidence to build their capacity. However, growers also need assistance, as barriers such as: knowledge gaps, time constraints and resources affect their decision making processes. Therefore, there is a need for the NCDP to continue and focus on capacity building of growers. Work learn processes and communication is suggested to include problem solving, referencing, examples and doing exercises, and a repeat, reflect and evaluate process. This approach is one suggestion that will improve the adoption rate of new technology from the NCDP project. As indicated above, while the adoption rate is high at 62%, the 37% difference between learning new information at 99% and actually implementing new practice on farm (62%) could be reduced.

The NCDP effectiveness may possibly be improved by implementing small focused regional grower groups. These groups implement new technologies on small trial sites on group member properties. Assistance could be provided from local extension officers and researchers under the guidance of the NCDP to ensure alignment with national priorities. These growers are then able to provide creditable advice to other growers in their region and growers can view the sites first hand and make informed decisions. This approach is suggested to increase grower awareness of new strategies that assist in improving their business enterprises and industry profitability. Improved grower understanding of preharvest management issues (cultivars, rootstocks, yield stability, pest and disease, irrigation, nutrition, soil health) that affecting their profitability and reduce risks and increase product quality and pack outs needs to continually addressed, due to changing market requirements and consumer demands. Furthermore, there is an urgent and crucial need to reduce input costs and the development of new technologies using automation and cherry specific programs to improve pack house efficiency. The use of yearly road show events and additional focus groups and training workshops conducted in each state to impart new technologies and strategies via several communication strategies should be undertaken via information and formal communication channels to enhance grower access to new information. This could be achieved by holding bi-monthly, short on line (phone/computer) communication workshops to increase industry communications, industry awareness of problems, develop solutions and new technologies. The development of an industry SMS alert application, that growers can install on their phones to receive updates on cherry industry news, workshops, training sessions, alerts on potential disease or pest outbreaks or where new information can be obtained (websites etc.). Development of a site within the industry stakeholder's website, a chat room, will enable growers to discuss problems and solutions. In addition, website links to new international research information and development of a new domestic and export market information website that provides daily price and volume data would be of value. However, the use of these technologies need to be explored and costed under a cherry industry program.

A full list of industry priorities raised by the NCDP is presented in Appendix K at the end of 2016. In early 2017 reference group members from this extensive list made the following suggestions for inclusion in a new NCDP on March 14th 2017 Minutes. These include:

1. Industry predictors
    a) Chill unit estimates
    b) Flowering, Fruit set, and Fruit growth and forecasting (GDD)
2. Industry benchmarking
    a) Standards for cherries
    b) NCDP to develop measures and tools
3. Basic cherry growing information a problem area
    a) Cherry production Manual
    b) Pollination - stem off issues
4. Agribusiness and economics
    a) Domestic, export and logistics
    b) Profitability
    c) Marketing poor fruit and over supply?
5. Demonstration Orchards

a) Growers have to commit to setting up demonstrations on their orchards and funding these themselves. However growers need in setting up and help to carry out assessments and evaluation. This is a job for NCDP coordinating team. Scale and evaluation has to be applicable to commercial operation to ensure information obtain is highly relevant.

6. Study tours for growers

Recommendations

- The NCDP continue for a second four year phase due to industry and grower support indicated in the evaluation conducted at the end of this project.
- The NCDP continue to assist in the education of Australia growers using various communication methods (road shows, growers in-field discussion sessions, informal and formal information sessions, workshops and training sessions and information websites
- The NCDP continue with the engagement of a consultant with excellent ability to communicate to growers and with enough experience in the cherry industry to assist with grower in-field discussion sessions and training.
- Provision of information must occur in a collaborative and interactive manner, and the providers of information and the NCDP must be involved and highly interested in the industry.
- The education of growers to include engagement of international and domestic cherry experts (researchers, growers, consultants, rural advisors and growers) from Europe, South America and North America and Asia. They must provide the latest information on cherry research conducted overseas and in Australia. Continue grower education on:
    - Pest and disease management linked to the Cherry Industry Biosecurity Management Plan, updating crop monitoring guide, IPDM calendar, on farm and postharvest chemical usage and requirements for individual country exports.
    - Chill unit estimates, flowering, fruit set and fruit growth forecasting (growing degree days etc.) including fruit shedding and shy bearing
    - Cultivars, rootstocks and their interactions, and their interaction with the Australian cherry growing environments
    - Training systems, tree architecture, canopy management and orchard design including protective cropping systems and fruit cracking issues
    - Production and performance, fruit growth and quality, crop loading, nutrition and irrigation practices
    - Postharvest management practices, harvest indices, stem retention, packaging, shelf life, and pack house operations and collaborative links to marketing and CGA specification (consumer acceptance, retail requirements, value chain issues and export intelligence and information)
- Development of a cherry grower alert system (SMS communication apps alert software and use of social media e.g. Facebook Twitter, etc.). This will to provide cherry growers with smart phone alerts on upcoming information session, field days, road shows and information releases on websites etc.
- Continue support through publishing information on TIA, CGA websites and continue to develop good collaboration with the cherry industry communication CORETEXT group.
- The NCDP establish local regional grower groups to conduct research on issues and priorities that are crucial to their economic survival. Growers to contribute to funding their own research sites with assistance (on concepts, set up, and data collection for validation of research and discussion sessions with other growers to highlight results). These evaluation sites and need to be highly relevant and reflect a commercial operation. This will ensure the information obtained is highly applicable to the cherry industry. A subsection of this aspect is to include a program for new entrants into the cherry industry.
- Connections enhanced with local advisors (NSW, Kevin Dodds, Adam Coleman, Dr Rebecca Darbyshire), (Vic, Dr

Ian Goodwin and consultant Charlotte Brunt) (SA, Dr Darren Graetz and EO at Cherry Growers SA, Suzie Green) (WA, Dianna Fisher) (Tas, TIA) in collaboration with the NCDP coordinating committee and CGA.

- The NCDP to develop and conduct grower study tours domestically and internationally with grower's contribution to their own travel and accommodation costs.
- The NCDP to develop and conduct a strategic benchmarking program to collect and collate vital cherry industry information.
- The NCDP to update the Australian Cherry Production Guide using a format that can be easily updated and published at a minimal cost and made available through CGA website, collaborating agencies websites and internet linkages.
- The NCDP to develop an economic app for growers. The building of the economic calculator could be based on a previously economic spreadsheet developed by Mr Nissen at TIA and combined with another economic calculator by AK Consultants. This app to include gross margin analysis, establishment costs, annual cash flows, pack out, fruit size, market price and profitability analysis identifying fixed and variable costs, cost of production (box, tree, orchard), accumulated cash discount flow graph, breakeven point and sensitivity analysis.
- The NCDP to develop grower market readiness training for domestic and export markets to assist growers, packers, wholesalers, agents and marketers and retailers.
- The NCDP to develop a postharvest manual for pack houses. This manual to incorporate, harvest indices for domestic and export markets, harvesting methods, pack house labour management, pack house process flows and logistics, packaging types including new smart packaging, consumer packaging, transport packaging and unit packaging, labelling, handling systems, cool room designs specifications, sorting and grading equipment, and include existing domestic and export quality specifications and product language, pest and disease identification and problem solver section.

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The NCDP also wish to thanks individual cherry growers who have served on the reference committee during the life of the project. Their support, time commitment to attend road show meeting and input in developing priorities and raising grower issues has enabled this program to be highly responsive to grower needs for industry. In addition, cherry growers who volunteered their properties to conducts field days and road show events. The growers are: John Odell, Guy Roth, Craig Stubs, Stuart Walton, Al Turnbull, Sam Riggall, Kathy and George and Kathy Grozotis, Chris and Tony Hall, Cliff, Glenn and Stephen Riseborough, Tom Eastlake, Fiona Hall, Nick Noski, Sue Green, Andy Flavell, Nic Hansen, Fiona Hall, Alison Jones, Steve and John Chapman, Fiona Poge, Kate Noller, Phyl Pike, Andrew Hall, Mark Salter, Nick Owens, Howard Hansen and Tim Reid. If we have missed naming any growers who have participated and provided input we unreservedly apologise.

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A special mention to Dr Penny Measham who started this program with Dr Dugald Close and for their enthusiasm and due diligence in making the program a success. In addition, Dr Penny Measham in her new role at Hort Innovation in the area of Queensland fruit fly (Qfly) Area Wide Management (AWM) thank you for participating in road show events to raise awareness of QFF. Furthermore, Mr Dan Ryan Hort Innovation Program Director of the SITplus consortium who also provided information on the SIT program.

A special thank you to NCDP consultant Peter Morrison for all his efforts and for participating and assisting in NCDP and conducting the grower field sessions in the locations where the road show events were held.

Appendices

Appendix A - NCDP Project Schedule of Activities in 2013

Year	Month	Scheduled activity
2013	July	Collate feedback from States - priorities
2013	July	Introduce the program schedule and undertake extension event (without consultant activity) in each State and distribute survey
2013	July	Commence tender process for consultant
2013	August	Regional coordinators to prompt survey responses
2013	Sept	Evaluation from individual growers/State Associations/regional coordinators to national coordinator
2013	Oct - Nov	National coordinator and state-based regional coordinators to review 1.Survey responses 2.List of future topics and presenters 3.Review of Tenders (2013)
2013	Nov	National coordinator to develop and submit milestone report
2013	Nov-Dec	Provide State Associations with a potential list of topics for the next extension event
2013 -2014	Nov - Jan	Regional coordinators liaise with industry members and State association regarding priorities
2014	Jan	Collate feedback from States
2014	March	Draft program developed in consultation with program team, consultant and R&D committee
2014	April	Finalise program and commence publicising
2014	April	National coordinator to develop and submit milestone report
2014	May-July	Extension activities (Orchard activity, presentations and discussions) undertaken in 5 states and distribute survey
2014	July	'On the day' evaluations of events from state reps forwarded to national coordinator
2014	August	Regional coordinators to prompt survey responses
2014	Sept	Evaluation from individual growers/State Associations /regional coordinators to national coordinator
2014	Sept	Round-table follow-up workshop with growers in each state
2014	Oct - Nov	National coordinator and state-based regional coordinators to review 1.Survey responses 2.Level of adoption anticipated 3. Planning cycle and progress of program to date 4.List of future topics and presenters
2014	Nov	National coordinator to develop and submit milestone report
2014	Nov-Dec	Provide State Associations with a potential list of topics for the next extension event
2014 -2015	Nov - Jan	Regional coordinators liaise with industry members and State association regarding priorities
2015	Jan- Dec	As per 2014, with continuous review and amendments made based on Industry feedback and needs
2016	Jan-Nov	As per 2014, with continuous review and amendments made based on Industry feedback and needs
2016	Dec	Review of program to date – decision regarding need for continuation of program or development of new program
2017	Jan-May	As per 2014, but activity if decided to be held in May only
2017	Jan-May	Development of guidelines for conducting extension to support Industry development Development of final report in consultation with program team members

Appendix B – NCDP Consultant request for quotation

TASMANIAN INSTITUTE OF AGRICULTURE

TIA is a joint venture of UTAS and the Tasmanian Government

REQUEST FOR QUOTATION

CONSULTANCY TO CONTRIBUTE TO A NATIONAL CHERRY INDUSTRY DEVELOPMENT AND EXTENSION PROJECT THROUGH THE TASMANIAN INSTITUTE OF AGRICULTURE

UTAS Tasmanian Government

Contents

PART A – CONDITIONS FOR REQUEST FOR QUOTATION

Lodging Quotations

Contact Officer

The Contact Officer in TIA who can provide further information about the proposed project is:

Dr. Penny Measham
Perennial Horticulture Centre
Tasmanian Institute of Agriculture
Private Bag 98
Hobart TAS 7001 Australia
Telephone +61 3 62261870 Mobile 0437454622
Penelope.Measham@utas.edu.au

It is recommended that intending respondents to this Request for Quotation seek additional information from Dr Measham during preparation of their response.

Location for Lodgement of Quotations

All Quotations must be delivered to:
Mr Robert Brockman,
Senior Finance Officer – SET Hub,
Private Bag 50, Hobart Tasmania 7001

Or

In electronic format (pdf) to: Robert.Brockman@utas.edu.au

Deadline for Lodgement of Quotations

Quotations must be lodged on or before **5.00 pm (EST) 10th January 2014**

Extension of Deadline

At any time before the Deadline for Lodgement of Quotation, the University of Tasmania ("University") may extend the closing time by up to 14 days by:

(a) informing all individuals/companies who have lodged a Quotation as at the date of variation; and

(b) notifying all persons who have been issued with a Request for Quotation by the University and who have provided sufficient address details to enable the University to contact them.

Suspension or Cessation

The University may at any time cease to proceed with, or suspend, the process outlined in the Request for Quotation.

No Contract orUndertaking

Nothing in this Request for Quotation is to be construed as creating a binding contract between the University and an individual or company. The Request for Quotation must not be construed as making any express or implied representation, undertaking or commitment by the University that it will enter into a binding contract with any person to supply the University's requirements.

Confidentiality and Intellectual Property

The Request for Quotation remains the property of the University. It may only be used for the purpose of preparing a quotation and conducting contract negotiations with the University.

The information in the Request for Quotation and all information concerning the University received as a result of, or in connection with, the submission of Quotation which the University has indicated is confidential or which the person receiving the information know or ought to know is confidential, must be kept confidential.

All Quotations and accompanying documents become the property of the University and the person submitting the Quotation authorises the University, its officers, employees, agents and advisers to adapt, modify, disclose, reproduce or do anything else necessary (in the University's sole opinion) to the whole or any portion of the Quotation for the purposes:

- evaluation;
- negotiating and/or entering into a contract with any party for the delivery of the University's Requirements or similar requirements;
- managing a contract (if any); or
- anything else related to the above purposes, including governmental and parliamentary auditing and reporting requirements.

Formation of Contract

The successful consultant will be required to sign a formal agreement containing terms and conditions of which the services will be provided supplemented by the addition of relevant information, requirements or variations:

- contained in the successful Quotation;
- arising during the evaluation process; and
- arising out of negotiations after the evaluation process.

Conflict of Interest

Individuals or companies providing a quotation must identify any actual or potential conflict of interest with the University.

Right to Negotiate

During the period of the evaluation process, the University may negotiate with respondents to vary their quotations either on the grounds of technical capability, cost, effectiveness, or matters relating to the combination of one part of the Request for Quotation with another part of the Request for Quotation document. The University also reserves the right to negotiate with several respondents to finalise the commercial terms to form a contract.

Taxation

The respondent must provide its Australian Business Number (ABN). If no ABN is held by the respondent the reason for not having an ABN must be stated. Should respondents choose not to register or disclose details of their ABN, PAYG withholding tax may apply and the University is required by law to deduct the relevant amount from any payment under the Contract for Professional Services and to remit the relevant amount to the Australian Taxation Office.

Evaluation of Quotations

The objective of the evaluation is to identify the Quotation that best meets TIA's requirements and represents value for money for TIA.

Compliant Quotations

To be considered for evaluation, a Quotation must include:

1. a written proposal addressing the Statement of Requirements, including the proposed methodology
2. the price for deliverables
3. a proposed timeframe
4. a statement addressing the evaluation criteria (following)
5. a statement of past experience in providing similar services, including a list of referees whom TIA may contact
6. the individual's or company's details and a contact for liaison and notices

Evaluation Criteria

Quotations will be evaluated against the following criteria:

Criteria (Essential) and assessment weight (%)

1. Knowledge of a variety of current cherry orchard management practices in Australia and internationally, and an ability to practically demonstrate such knowledge (20%)
2. Demonstrated capacity to work consultatively with a diversity of stakeholders and expert groups, and to provide solutions, advice and recommendations. (20%)
3. Experience in providing practical advice and understanding of tree responses to management practices (15%)
4. Demonstrated capacity to coordinate and deliver field-based activities to a variety of stakeholders (15%)
5. Demonstrated capacity to respond to client priorities in developing extension projects (15%)
6. Value for money. (15%)

Criteria (Desirable)

1. An understanding of the Australian Cherry Industry regions, regional challenges, and common national challenges and strengths
2. An understanding of the Australian Cherry Industry in the global context

Advice of Decision and Debriefing

All individuals and companies lodging a Quotation will be informed of the outcome at the conclusion of the evaluation process. An opportunity will be provided for a debriefing, if required, in a manner specified by TIA.

Price

The price should be structured to enable all the elements outlined in the Statement of Requirements to be addressed. The price should clearly identify all costs, fees, allowances and charges. Any travel and accommodation expenses must be included in the price. All quotes must be on a GST exclusive basis. The University is not obliged to accept the lowest priced or any other Quotation.

PART B – STATEMENT OF REQUIREMENTS

Background

The Tasmanian Institute of Agricultural Research (TIA) is a joint venture between the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE) and the University of Tasmania (UTAS). Within TIA, the Perennial Horticulture Centre (PHC) focuses its attention on orchard management, integrated disease management, and crop physiology. The research, development and extension from TIA's PHC is assisting the maintenance and expansion of horticultural industries and TIA is the lead agency for cherry Research, Development and Extension (RD&E) under the National RD&E framework. TIA's PHC works closely with Cherry Growers Australia (CGA), state industry bodies and Horticulture Australia Limited (HAL) to support the development of the Cherry Industry RD&E strategic plan. From this plan, a national cherry industry development program is being initiated; this is to be led by TIA and CGA, with collaboration with all state agencies and other research providers. The program will coordinate a national 'road show' of one-day events, to be conducted between May and July each year. These will include field site visits (one per state per year for three years) and could include practical demonstrations of key management issues. It is anticipated that a mix of research and consultant presentations would be well received. The national program coordinator will attend each event. The objectives of the program are to increase capability and capacity for innovation and knowledge sharing, increase understanding of novel research outcomes with the ability to apply outcomes, increase the engagement of the research community in industry development and form strong collaborative links between all industry stakeholders. This program for efficient and effective delivery of RDE in Australia is aligned to industry priorities and strategic plans, and national and state priorities.

Overview of consultancy

TIA is now seeking quotations from individuals or companies to contribute to this development program by coordinating and undertaking engagement events (workshops/field events/presentations) in each state in each of the years 2014, 2015 and 2016. Exact dates and times, and potential topics/content will be developed by the program team prior to these events through a series of key meetings. Therefore, contributions must be responsive to the seasonal and regional challenges identified in the lead up to engagement events. The program operates in such a way that consultation and feedback is undertaken regularly (see timeline) in order to ensure a suitable yearly program of industry engagement activities. TIA, as lead agency, will be responsible for developing and coordinating the entire program, with consultancy contributing to the program. In addition to undertaking events, contribution also includes liaising with the national coordinator and other team members throughout the year. Contribution furthermore includes review of engagement event participation, understanding and likely adoption, and preparing reports for the national coordinator.

The consultant's task with regard to this request for quotation, and in addressing the Statement of requirements, is to develop, justify and cost engagement events for a national cherry development program that support the objectives of the broader program.

Key Milestones and Timeline

Refer to the following table of key dates when preparing a quotation.

The national development program will be undertaken as per the defined timeframe;

November	State associations and representatives provided with a potential list of topics and presenters, taken from current R&D projects
January	Responses and other state/regional topics collected from each region
March	Draft program developed in consultation with consultant, R&D committee and state representatives.
April	Program finalised with state coordinators and others involved
May-July	Road show engagement events to occur in 5 states
July	'On the day' evaluations of events collated and forwarded to national coordinator
July-Sept	Evaluation from consultant and participating growers forwarded to national coordinator
Oct - Nov	National coordinator, state-based regional coordinators and consultant to review 1. Planning cycle and progress of program to date 2. List of possible topics and presenters for following year
Nov	National coordinator to collate and review information, submit milestone report to funding body
Nov-Dec	Planning cycle begins again

NCDP Grower Update Introducing Mr Peter Morrison as program consultant

The National Development Program

Grower Update

April 2014

The national development program (NDP) for the Australian cherry industry has a new member. Peter Morrison is now working with the NDP as a consultant, and will be visiting states over the coming months. Peter has been an agronomist in perennial horticulture for 19 years. He has worked on a production orchard for a few years, and before that completed a traineeship and trade certificate on a fruit tree nursery and orchard. Peter has provided agronomic services, training and extension to the cherry industry both in Australia and internationally. He has enhanced his knowledge by travelling to the U.S, Canada and New Zealand in the last 5 years to look at how other growers and agronomists grow their cherries and manage their problems with this crop. Peter believes it's important to understand the issues faced in different regions, and get to know the systems used by each grower.

"I know I can make a difference for growers when it comes to relaying research findings to them in a way that they can understand and use the information."

Peter is helping the program now to develop activities for states this year. Feedback from states (via a consultative process) has been predominantly focused around export readiness. Program members are now helping with the progression of the biosecurity management plan. Keeping up-to-date with progress on export market protocols will mean that export-ready activities will be relevant. Feedback also included requests for knowledge around fruit quality so the NDP will also explore the latest R&D on quality, especially fruit firmness, to include in activities.

In the meantime, should you have any queries or concerns about the NDP, please talk to your state NDP member, listed below. State members have been active and are making excellent contributions to your program. Please continue to provide your thoughts about what your industry needs and together help direct support and development. And look out for future updates and information!

State members;
Anne Mooney (NSW)
Alison Jones (VIC)
Phil Pyke (TAS)
Darren Graetz (SA)
Stephanie Faggetter (WA)
Penny Measham (co-ordinator)

This project has been funded by Horticulture Australia Ltd using the cherry industry levy and matched funds from the Australian Government.

Appendix C - NCDP Reference Group Road Show Event Contents

National Cherry Industry Development Program Dates

Itinerary for the National Cherry Industry Development Program Road Show event for 2016:

Date	Flights & Car Hire	Departure Time & Location	Arrival Time & Location	Comments
2/10/2016	Flight	Arrival of As/Prof Dr Mathew Whiting	11: 15 am	
3/10/2016	**Car Hire**	**8:00 am Melbourne**	**9:00 am Yarra Valley**	**Road Show Event in Yarra Valley**
4/10/2016	**Road Show Event Young**	**1:00 pm Young**	**8:00 pm Young**	**Road Show Event in Young**
5/10/2016	**Road Show Event Orange**	**1:00 pm**	**8:00pm**	**Road Show Event in Orange**
7/10/2016	**Road Show Event Adelaide Hills**	**9:30 am Adelaide Hills**	**4:00 pm Adelaide Hills**	**Road Show Event in Adelaide Hills**
10/10/2016	**Road Show Event at Cherries Tasmania, Old Beach**	**9:30 am Tasmania**	**4:00 pm Tasmania**	**Road Show Event at Cherries Tasmania, Old Beach**
12/10/2016	Flight	Departure of As/Prof Dr Matthew Whiting	6:00 am	

National Cherry Development Program

Cherry Road Show 2016

Find out the latest in local, national and international cherry research at ***Cherry Roadshow 2016***.

- Field walks
- In Field discussions
- International Guest Speaker

Internationally recognised cherry expert Associate Professor Matthew Whiting (Washington State University) will talk about the latest cherry research and orchard practices from the US.

- **When:** Monday 3rd October
- **Time:** 9:00 am to 5:00pm
- **Venue: Cherryhill Orchard, 474 Queens Road, Wandin East.**

RSVP: by Monday, 26th September
Phone: Fiona Pogue 03 5825 3700 **Email:** info@cherries.org.au

Key note speaker: Associate Professor Matthew Whiting, Washington State University

- Pollination and fruit set
- Crop loading, carbohydrate accumulation, partitioning, mechanical pruning & cherry stem retention

Field walks - In field discussions with Mr Peter Morrison, Roberts Ltd

- Session 1: cultivars, rootstocks, training systems and crop loading issues.
- Session 2: pest and diseases, harvesting and handling.

National Cherry Development Program, Mr Bob Nissen, Tasmanian Institute of Agriculture

- What has been done?
- What can be done better?
- How to improve grower participation and collaboration in the road show events?
- Reference committee make up?
- Design of workshops and information exchange sessions, roving field days for growers to receive the most up to date information?

Timetable of planned activities for Road Show in Victoria

Time	Activity / Topic	Facilitator
9:00 – 10:00 am	Arrival – Road show participants (Growers and facilitators) provided with refreshments (tea, coffee and small snack (Biscuits or cake etc.).	
10:00 – 10:15 am	Welcome and introduction of Road Show facilitators and Topics.	
10:15 – 10:45 am	**Guest Speaker Topic:- Pollination, fruit set and fruit retention**	Assoc Prof Dr Mathew Whiting
10:45 – 11:15 am	Discussion session and question time on:- Pollination, fruit set and fruit retention	Assoc Prof Dr Mathew Whiting, Dr Dugald Close, Mr Bob Nissen and Mr Peter Morrison
11:15 – 11:45 am	**Guest Speaker Topic:- Crop loading, carbohydrate accumulation, partitioning, mechanical pruning and stem retention**	Assoc Prof Dr Mathew Whiting
11:45 – 12:30 pm	Discussion session and question time on: Crop loading, carbohydrate accumulation, partitioning, mechanical pruning and stem retention	Assoc Prof Dr Mathew Whiting, Dr Dugald Close, Mr Bob Nissen and Mr Peter Morrison
12:30 – 13:00 pm	Lunch	Local Cherry Growers Associations in each state to assist with lunch provisions to participants.
13:00 – 13:30 pm	Discussion session on continuation of National Cherry Development Program. Survey to obtain information on advantage and disadvantages of National Cherry Development Program.	Mr Bob Nissen, Dr Dugald Close and Mr Peter Morrison
13:30 - 14:30 pm	Field walk and discussion sessions Session one of field walk:- Cultivars, Rootstocks, training systems, crop loading Session two of field walk:- pest and diseases, harvesting and handling	Growers need to evaluate their own situation on their properties and come ready with questions for Peter Morrison. Mr Peter Morrison to facilitate and discuss issues with growers.
14:30 – 15:00 pm	Afternoon refreshment break	
15:00 – 17:00 pm	Departure of Road show participants (Growers and facilitators)	

National Cherry Development Program

Cherry Road Show 2016

Find out the latest in local, national and international cherry research at ***Cherry Roadshow 2016***.

- Field walks
- In Field discussions
- International Guest Speaker

Internationally recognised cherry expert Associate Professor Matthew Whiting (Washington State University) will talk about the latest cherry research and orchard practices from the US.

Young

- **When:** Tuesday 4th October
- **Time:** 12:30 pm to
- **Venues: Chris Hall Wombat and**
- **Thai restaurant**

Orange

- **When:** Wednesday 5th October
- **Time:** 12:30 pm to
- **Venue: Roy and Tory Williams Orchard – 121 Carlton Road and Kelly's Hotel Orange.**

RSVP: by Monday, 26th September

Phone: Kate Noler 0432 920 362 | **Email:** secretary@NSWcga.com.au

Key note speaker: Associate Professor Matthew Whiting

- Pollination and fruit set
- Crop loading, carbohydrate accumulation, partitioning, mechanical pruning & cherry stem retention

Field walks - In field discussions with Mr Peter Morrison (Agronomist, Roberts Ltd)

- Session 1: cultivars, rootstocks, training systems and crop loading issues.
- Session 2: pest and diseases, harvesting and handling.

Biosecurity Issues: Dr Penny Measham
Queensland Fruit Fly (QFF) biosecurity issues and latest developments

National Cherry Development Program, Mr Bob Nissen (TIA, Research Fellow)

- What has been done?
- What can be done better?
- How to improve grower participation and collaboration in the road show events?
- Reference committee make up?
- Design of workshops and information exchange sessions, roving field days for growers to receive the most up to date information?

Timetable of planned activities for Road Show in NSW Young and Orange

Time	Activity / Topic	Facilitator
12:30 – 1:00 pm	Arrival – Road show participants (Growers and facilitators) provided with refreshments (tea, coffee and small snack (Biscuits or cake etc.).	Local Grower Association in Young and Orange
1:00 – :15 pm	Welcome and introduction of Road Show facilitators and Topics.	
1:15 – 2:15pm	Field walk and discussion sessions Session one of field walk:- Cultivars, Rootstocks, training systems, crop loading Session two of field walk:- pest and diseases, harvesting and handling	Growers need to evaluate their own situation on their properties and come ready with questions for Peter Morrison. Mr Peter Morrison to facilitate and discuss issues with growers. This session by Peter Morrison leads into Dr Penny Measham session on QFF. Dr Penny Measham may wish to provide some input on QFF
2:15 – 3:15 pm	Biosecurity issues for QFF:- establishment of low pest incidence areas, monitoring and trapping, wide area management, market access, pre harvest treatments, and end point treatments	Dr Penny Measham and one Biosecurity Officer
3:15 – 3:30 pm	Discussion session and question time	Dr Penny Measham and Biosecurity Officer, Mr Bob Nissen
3:30 – 4:00 pm	Break - Afternoon Refreshments	
4:00 – 5:30 pm	Discussion session on continuation of National Cherry Development Program. Survey to obtain information on advantage and disadvantages of National Cherry Development Program.	Mr Bob Nissen and Mr Peter Morrison
5:30 – 6:30 pm	Meeting adjourns to venue for Dinner	Over Dinner Assoc Prof Dr. Mathew Whiting will present his talks
Time	Activity / Topic	Facilitator
6:30 – 7:00 pm	Guest arrive and settle for dinner	Growers and guests have to pay for their own dinner meals, drinks etc. The project has no approval or funds to expend on dinners and drinks. Therefore, this will have to be covered by the growers and guest attending the Road Show.
7:00 – 7:30 pm	Guest Speaker Topic: Pollination, fruit set and fruit retention.	A/ Prof Dr Mathew Whiting
7:30 – 7:45 pm	Discussion session and question time on: Pollination, fruit set and fruit retention.	A/ Prof Dr Mathew Whiting, Dr Dugald Close, Mr Bob Nissen and Mr Peter Morrison
7:45 – 8:15 pm	Guest Speaker Topic: Crop loading, carbohydrate accumulation, partitioning, mechanical pruning and stem retention	A/ Prof Dr Mathew Whiting
8:15 – 8:30 pm	Discussion session and question time on: Crop loading, carbohydrate accumulation, partitioning, mechanical pruning and stem retention	A/ Prof Dr Matt Whiting, A/Prof Dugald Close, Mr Bob Nissen and Mr Peter Morrison
8:30 – 9:00 pm	Departure of Road show participants (Growers and facilitators)	Local Cherry Growers Associations in each state to assist with lunch provisions to participants

National Cherry Development Program

Cherry Road Show 2016

Find out the latest in local, national and international cherry research at ***Cherry Roadshow 2016***.

- Field walks
- In Field discussions
- International Guest Speaker

Internationally recognised cherry expert Associate Professor Matthew Whiting (Washington State University) will talk about the latest cherry research and orchard practices from the US.

- **When:** Friday 7th October
- **Time:** 9:00 am to 3:00 pm
- **Venue: Nick Noske's 255 Haris Road, Lenswood.**

RSVP: by Tuesday, 27th September
Phone: Andy Falvell 0418 833 428 **Email:** afsflavell@adam.com.au

Key note speaker: Associate Professor Matthew Whiting, Washington State University

- Pollination and fruit set
- Crop loading, carbohydrate accumulation, partitioning, mechanical pruning & cherry stem retention

Field walks - In field discussions with Mr Peter Morrison, Roberts Ltd

- Session 1: cultivars, rootstocks, training systems and crop loading issues.
- Session 2: pest and diseases, harvesting and handling.

National Cherry Development Program, Mr Bob Nissen, Tasmanian Institute of Agriculture

- What has been done?
- What can be done better?
- How to improve grower participation and collaboration in the road show events?
- Reference committee make up?
- Design of workshops and information exchange sessions, roving field days for growers to receive the most up to date information?

Timetable of planned activities for Road Show in South Australia

Time	Activity / Topic	Facilitator
9:00 – 10:00 am	Arrival – Road show participants (Growers and facilitators) provided with refreshments (tea, coffee and small snack (Biscuits, fruit or cake etc.).	
10:00 – 10:15 am	Welcome and introduction of Road Show facilitators and Topics.	
10:15 – 10:45 am	**Guest Speaker Topic:** **Pollination, fruit set and fruit retention**	A/ Prof Dr Mathew Whiting
10:45 – 11:15 am	Discussion session and question time on:- Pollination, fruit set and fruit retention	Assoc Prof Dr Mathew Whiting, Dr Dugald Close, Mr Bob Nissen and Mr Peter Morrison
11:15 – 11:45 am	**Guest Speaker Topic:- Crop loading, carbohydrate accumulation, partitioning, mechanical pruning and stem retention**	Assoc Prof Dr Mathew Whiting
11:45 – 12:30 pm	Discussion session and question time on: Crop loading, carbohydrate accumulation, partitioning, mechanical pruning and stem retention	Assoc Prof Dr Mathew Whiting, Dr Dugald Close, Mr Bob Nissen and Mr Peter Morrison
12:30 – 13:00 pm	Lunch	Local Cherry Growers Associations in each state to assist with lunch provisions to participants.
13:00 – 13:30 pm	Discussion session on continuation of National Cherry Development Program. Survey to obtain information on advantage and disadvantages of National Cherry Development Program.	Mr Bob Nissen, Dr Dugald Close and Mr Peter Morrison
13:30 - 14:30 pm	Field walk and discussion sessions Session one of field walk:- Cultivars, Rootstocks, training systems, crop loading Session two of field walk:- pest and diseases, harvesting and handling	Growers need to evaluate their own situation on their properties and come ready with questions for Peter Morrison. Mr Peter Morrison to facilitate and discuss issues with growers.
14:30 – 15:00 pm	Afternoon refreshment break	
15:00 – 17:00 pm	Departure of Road show participants (Growers and facilitators)	

National Cherry Development Program

Cherry Road Show 2016

Find out the latest in local, national and international cherry research at ***Cherry Roadshow 2016***.

- Field walks
- In Field discussions
- International Guest Speaker

Internationally recognised cherry expert Associate Professor Matthew Whiting (Washington State University) will talk about the latest cherry research and orchard practices from the US.

- **When:** Monday 10th October
- **Time:** 9:30 am to 3:00 pm
- **Venue: Cherries Tasmania, 32 Harvest Lane, Old Beach 7017**

RSVP: by Monday 3rd October

Phone: Fruit Growers Tasmania | 03 6231 1944 | **Email:** office@fruitgrowerstas.com.au

Key note speaker: Associate Professor Matthew Whiting, Washington State University

- Pollination and fruit set
- Crop loading, carbohydrate accumulation, partitioning, mechanical pruning & cherry stem retention

Field walks - In field discussions with Mr Peter Morrison, Roberts Ltd

- Session 1: cultivars, rootstocks, training systems and crop loading issues.
- Session 2: pest and diseases, harvesting and handling.

National Cherry Development Program, Mr Bob Nissen, Tasmanian Institute of Agriculture

- What has been done?
- What can be done better?
- How to improve grower participation and collaboration in the road show events?
- Reference committee make up?
- Design of workshops and information exchange sessions, roving field days for growers to receive the most up to date information?

Timetable of planned activities for Road Show in Tasmania

Time	Activity / Topic	Facilitator
9:00 – 10:00 am	Arrival – Road show participants (Growers and facilitators) provided with refreshments (tea, coffee and small snack (Biscuits or cake etc.).	
10:00 – 10:15 am	Welcome and introduction of Road Show facilitators and Topics.	
10:15 – 10:45 am	**Guest Speaker Topic:- Pollination, fruit set and fruit retention**	Assoc Prof Dr Mathew Whiting
10:45 – 11:15 am	Discussion session and question time on:- Pollination, fruit set and fruit retention	Assoc Prof Dr Mathew Whiting, Dr Dugald Close, Mr Bob Nissen and Mr Peter Morrison
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11:45 – 12:30 pm	Discussion session and question time on: Crop loading, carbohydrate accumulation, partitioning, mechanical pruning and stem retention	Assoc Prof Dr Mathew Whiting, Dr Dugald Close, Mr Bob Nissen and Mr Peter Morrison
12:30 – 13:00 pm	Lunch	Local Cherry Growers Associations in each state to assist with lunch provisions to participants.
13:00 – 13:30 pm	Discussion session on continuation of National Cherry Development Program. Survey to obtain information on advantage and disadvantages of National Cherry Development Program.	Mr Bob Nissen, Dr Dugald Close and Mr Peter Morrison
13:30 - 14:30 pm	Field walk and discussion sessions Session one of field walk:- Cultivars, Rootstocks, training systems, crop loading Session two of field walk:- pest and diseases, harvesting and handling	Growers need to evaluate their own situation on their properties and come ready with questions for Peter Morrison. Mr Peter Morrison to facilitate and discuss issues with growers.
14:30 – 15:00 pm	Afternoon refreshment break	
15:00 – 17:00 pm	Departure of Road show participants (Growers and facilitators)	

Bio of Associate Professor Mathew Whiting.

Associate Professor Matthew Whiting directs Washington State University's stone fruit physiology research and outreach program, focusing on key horticultural and physiological issues facing the state's tree fruit industries. Dr. Whiting's program is leading the global transition to high efficiency orchard systems with a model of full industry collaboration in development and outreach.

His research and development of planar tree architectures for sweet cherry has facilitated the incorporation of automation and mechanization while improving yield, labor efficiency, and fruit quality. Dr. Whiting has also conducted applied research that has addressed crop load management, fruit set/pollination, novel high efficiency orchard systems, and incorporating automation/mechanization. Dr. Whiting has led collaborative research efforts in Canada, Chile, Turkey, and collaborated closely with Australian researchers on crop load and plant bio-regulators.

Dr. Whiting is a leading international researcher on cherries and has been invited to speak around the world on orchard systems innovations, pollination biology, and practical strategies for efficient production of high quality fruit.

National Cherry Industry Development Program Dates

Itinerary for the National Cherry Industry Development Program Road Show event for Western Australia in April 2017:

National Cherry Development Program

Western Australia Cherry Road Show 2017

Find out the latest in local, national and international cherry research at ***Cherry Roadshow 2017.***

- Information sessions
- Field walks and in-field discussions

- **When:** 5th April 2017
- **Time:** 9:30 am to 2:30 pm
- **Venue: Manjimup Western Australia**

RSVP: by 1st April 2017

Phone: Email: cherrylanefields1@bigpond.com

Information sessions by Dr Dugald Close and Bob Nissen on the latest cherry research by Associate Professor Matthew Whiting, Washington State University USA on:

- Pollination and fruit set
- Orchard Design, mechanical pruning , harvesting & cherry stem retention

Field walks - In field discussions with Peter Morrison, Roberts Ltd on:

- Session 1: cultivars, rootstocks, training systems and crop loading issues.
- Session 2: pest and diseases, harvesting and handling.

National Cherry Development Program, Bob Nissen, will provide information on the program about:

- What has been done?
- What can be done better?
- How to improve grower participation and collaboration in the road show events?
- Reference committee make up?
- Design of workshops and information exchange sessions, roving field days for growers to receive the most up to date information?

Timetable of planned activities for Road Show at Donnybrook, Western Australia

Time	Activity / Topic	Facilitator
9:00 – 10:00 am	Arrival – Road show participants (Growers and facilitators) provided with refreshments (tea, coffee and small snack (Biscuits or cake etc.).	
10:00 – 10:15 am	Welcome and introduction of Road Show facilitators and Topics.	
10:15 – 10:45 am	**Topic:-** **Pollination, fruit set and fruit retention**	Bob Nissen and Dugald Close
10:45 – 11:15 am	Discussion session and question time on:- Pollination, fruit set and fruit retention	Assoc Dr Dugald Close, Mr Bob Nissen and Mr Peter Morrison
11:15 – 11:45 am	**Topic:-** **Orchard Design, mechanical pruning, harvesting and stem retention from USA**	Assoc Prof Dr Dugald Close and Mr Bob Nissen
11:45 – 12:30 pm	Discussion session and question time on: Crop loading, carbohydrate accumulation, partitioning, mechanical pruning and stem retention	Assoc Prof Dr Dugald Close, Mr Bob Nissen and Mr Peter Morrison
12:30 – 13:00 pm	**Lunch**	Local Cherry Growers Associations in each state to assist with lunch provisions to participants.
13:00 – 13:30 pm	**Topic:** **Discussion session on continuation of National Cherry Development Program.**	Mr Bob Nissen, Dr Dugald Close and Mr Peter Morrison
13:30 - 14:30 pm	**Field walk and discussion sessions** Session one of field walk:- Cultivars, Rootstocks, training systems, crop loading Session two of field walk:- pest and diseases, harvesting and handling	Growers need to evaluate their own situation on their properties and come ready with questions for Peter Morrison. Mr Peter Morrison to facilitate and discuss issues with growers.
14:30 – 15:00 pm	Afternoon refreshment break	
15:00 – 17:00 pm	Departure of Road show participants (Growers and facilitators)	

Appendix D

Fact Sheets produced by the NCDP for Grower Training on Pests and Diseases.

Pest Fact Sheet
Fruit fly

Identification

There are 2 species of fruit fly that are a concern to cherry production; the Queensland fruit fly (*Bactrocera tryoni*) and the Mediterranean fruit fly (*Ceratitus capitata*). The adult flies look similar and are difficult to tell apart. The QFF can be up to 8mm long, while the MFF only reaches 5mm long. Both have dark yellow/brown bodies but the QFF has transparent wings, while the MFF has orange/brown bands across the wings. Larvae and pupae are also similar, but only QFF overwinters as an adult.

Mediterranean fruit fly (top)
with enlarged view of banded wings (bottom)

Damage

Fruit fly damage results from flies laying eggs in ripe and maturing fruit. This causes physical damage to the surface of the fruit (stings) and further damage when the eggs hatch. Stings can be seen in maturing fruit. The emerging larvae feed on the fruit. Damaged fruit is not only unmarketable due to feeding damage but quickly rots on the tree. Under ideal conditions rot can spread quickly increasing the level of damage.

Life Cycle

In cherry orchards, fruit fly are not often detected until late in the season (late summer) when populations peak. Fruit flies usually enter cherry orchards from other fruit orchards. Adult flies become increasingly active as spring progresses and lay eggs in maturing fruit. Eggs can hatch within a few days – the larvae remain in the fruit. When mature, larvae leave the fruit to drop to the soil to pupate.

Larval and pupal stages progress depending on temperature, but can be as little as 2 weeks. The QFF overwinters as adult flies, but the MFF overwinter as pupae.

Queensland fruit fly – transparent wings

Fruit fly are pests of concern to;

QFF – **China, Japan, Korea, Philippines, Taiwan. Thailand, USA**

MFF – **China, Japan, Korea, Philippines, Taiwan. Thailand, USA**

Monitoring and control

Monitoring for fruit fly involves trapping. To meet export requirements traps should be in place by bud burst and monitored until fruit is harvested. It may also be worthwhile to continue monitoring post-harvest for your own records, and to help build up a picture of when fruit fly are in your region. Fruit fly will continue to breed on unpicked and fallen fruit. Traps for both types of fruit fly are available – talk to you local supplier.

State departments also monitor for fruit fly – talk to your local department about what is happening in your region, and for updates on current distribution and zoning. For areas accepted as pest free, state monitoring is usually accepted under export protocols but check with them prior to the start of the season.

In addition, fruit should be monitored for 'stings' from the middle of the season as they mature. Appropriate action when fruit fly is detected includes bait spraying (bait plus insecticide) and when pressure is high - cover sprays. Refer to the IPM calendar and export manual spray program guide.

References

NSW DPI factsheet – managing QFF in citrus
NSW DPI 1995 IPDM manual – Summerfruit
PaDIL
http://www.padil.gov.au/

Pest Fact Sheet
Codling Moth

Identification

Codling moth eggs are oval-shaped, flat and about 1mm long. When first laid they are white, but develop a reddish ring with time. The larvae start out as a 2mm white grub with a black head, and then progresses through different larval stages to become cream/pink with a brown head. Larvae can reach up to 15mm long when mature.

Larvae remain dormant or pupate in a cocoon before emerging as adult moths. Adult codling moths can be up to 1cm long with a wingspan of up to nearly 2 cm; the females are usually bigger that males. They have mottled grey wings with dark brown tips and are often hard to spot.

Damage

Codling moth damage is not generally seen and there is evidence to support cherry not being a host plant for codling moth (Hansen & Lewis 2003; Hansen & Lewis 2011; Wearing & Hansen 2008; Wearing & McLaren 2001). In apples, codling moth larvae can enter the fruit by chewing the skin and boring. The larvae can feed on seeds and exude a brown 'frass' or secretion that forms on the fruit surface at the point of entry.

Life cycle

Adults emerge in spring, mate and lay eggs on leaves and fruit. Female moths release pheromones to attract male partners. Eggs are laid singly; females can lay up to 70 eggs. As soon as eggs hatch the larvae search for fruit to bore into and mature. Once mature the larvae exit the fruit, drop to the ground and find a suitable pupation site.

Pupation occurs in the soil, in plant debris, or under bark. Temperature effects the rate of development, but up to 3 generations can occur in an apple production season. As the weather cools, pupae can overwinter to emerge as adults the following spring.

Codling moths are pests of concern to;
Japan, Korea, Philippines, Taiwan

Monitoring and control

Monitoring is required to meet export protocols. This is undertaken in Tasmania by DPIPWE for export to Korea or Japan – talk to DPIPWE if this is your situation. Otherwise, it is recommended to monitor for codling moth by having at least one pheromone trap per registered block (up to 10 ha.) Pheromone traps are recommended more to determine the first flight of moths to develop an action plan, than to use as a control measure only. Maintaining good orchard hygiene (keeping weeds down and removing loose bark and pruning waste) will reduce the number of overwintering sites.

Chemical control should be timed to match hatching of eggs as once larvae enter fruit control is difficult. Using traps to find first flight will then give you a good indication of when eggs will hatch. This can be calculated by degree days; optimum temperatures for codling moth activity are between 10 and 31°C, 111 GDD required for egg hatch. Talk to your local agent for further information, but it is anticipated that control will not be needed. Refer to the export manual spray guide for available chemical options.

In cherries, monitoring for the presence of codling moth should be all that is required, given the support available for cherry not being a host plant. Continued monitoring may establish evidence for non-host status in Australia. Studies have even shown that codling moth (when given only cherry fruit into which to lay eggs) could not complete a full life cycle in cherry fruit (Hansen & Lewis 2003). Trap counts are reported to be low in cherry orchards, even when adjacent to pome fruit (Johnson & Hansen 2008).

References

Hansen, J. D., & Lewis, L. R. (2003). Field survival of codling moth (Lepidoptera: Tortricidae) on artificially infested sweet cherries. Crop Protection, 22(5)

Hansen, J. D., & Lewis, L. R. (2011). Pre-harvest survival of codling moth in artificially infested sweet cherry fruits. Crop Protection, 30(9)

http://www.ipm.ucdavis.edu/

Johnson, J. A., & Hansen, J. D. (2008). Evidence for the non-pest status of codling moth on commercial fresh sweet cherries intended for export. Crop Protection, 27(11)

Wearing, C. H. & McLaren, G. F. 2001. Evidence that sweet cherry, *Prunus avium* L. is not a host of codling moth, *Cydia pomonella*, (Lepidoptera: Tortricidae). Crop Protection, 20

Mature codling moth larvae

Pest Fact Sheet
Light Brown Apple Moth
Lesser Light Brown Apple Moth

Identification

Eggs from the apple moths are laid on upper surfaces of leaves in clumps of up to 80 eggs. They are small (less than 1mm), pale to begin with but progressively become yellow as they age. Just before hatching the dark head of the larvae become apparent. Larvae yellow/pale green and about 1mm long when emerging from eggs. They can reach up to 15mm long when mature. Larvae can have a central strip of darker green. Pupae are about 12 mm long.

The adult moths are pale yellow to pale brown. The adult apple moths can be up to 10mm long with a wingspan of up to nearly 2.5 cm; the females are usually bigger than males. The lesser light brown apple moth is so named as it is slightly smaller than the light brown apple moth, but otherwise it is extremely difficult to distinguish between the two. Talk to your local diagnostic agency regarding identification if you are concerned.

Damage

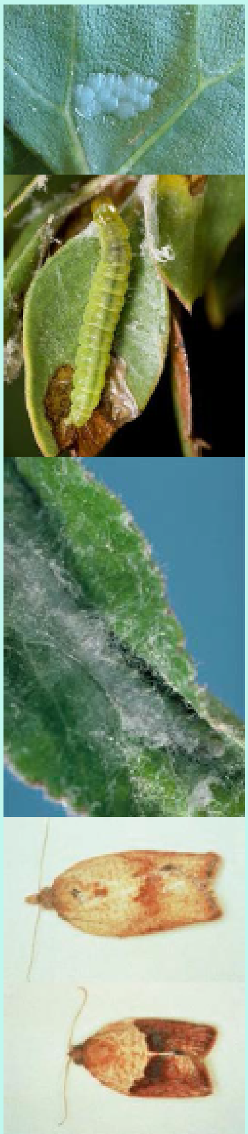
Apple moth damage is a result of the larvae feeding on buds, fruit, flowers, and leaves. Damage to fruit usually occurs as surface feeding, causing irregular brown areas forming on the surface of the fruit. The larvae will enter the fruit occasionally to feed.

In addition to this direct damage, apple moths are also linked with the spread of fungal infections such as botrytis. The webbing produced by the larvae in fruit bunches early during fruit development can lead to poor development, and the debris left within bunches increases the risk of fungal infection in bunches. The larvae will seek protection by spinning a webbed covering on the underside of leaves, or rolling a leaf closed altogether with webbing. This leaf rolling nature of the insect may also reduce leaf function.

Life cycle

Adults emerge through spring and into summer in consecutive generations. In Australia three generations have been noted under ideal conditions. The adult moths lay eggs on the upper sides of leaves, from which the larvae emerge after 1-3 weeks. Larvae search for protected areas to mature and pupate. Initially the undersides of leaves close to midribs are preferred sites and the larvae create a silken cocoon. As larvae mature the silken webbing may envelop whole leaves, or they may enter fruit bunches. This larval period lasts from 3-6 weeks, and then pupation occurs in the larval 'nests'. The moth overwinters as larvae (usually those from eggs late in the growing season or in Autumn) in plant debris or host plants such as weeds. Warmer weather then accelerates development, pupation occurs and the adult moths emerge and mate soon afterwards.

Light Brown Apple Moths are pests of concern to;
LBAM – **China, Korea, Thailand, USA**
LLBAM – **China, Korea**



From top to bottom: LBAM eggs, larvae, webbing and leaf-rolling, and female and male adult moths

Monitoring and control

Light brown apple moths have been noted in many regions of Australia, but prefer the cooler climates. Hot, dry climates can suppress moth numbers. Monitoring is required to meet export protocols. Monitoring for apple moths is undertaken using pheromone traps. Pheromone traps are used to determine the first flight of moths and to develop an action plan. Chemical control should be timed to match hatching of eggs. Flight dates and climate information can give you a good indication of when eggs will hatch. This can be calculated by degree days (130 GDD); optimum temperature for activity is between 7 and 30°C. Talk to your local agency for further information, and refer to the IPM calendar. Refer to the export manual spray guide for available chemical options.

Maintaining good orchard hygiene (keeping weeds down and removing loose bark and pruning waste) will reduce the number of overwintering sites. There are a number of parasitic insects of apple moths, so exercise caution when applying broad spectrum insecticides.

References

AWRI viti-notes: Characteristics of LBAM 2010
Burgi, L. P. & Mills, N. J. 2010. Cold tolerance of the overwintering larval instars of light brown apple moth Epiphyas postvittana. Journal of Insect Physiology, 56
Gutierrez, A. P., Mills, N. J. & Ponti, L. 2010. Limits to the potential distribution of light brown apple moth in Arizona-California based on climate suitability and host plant availability
GWRDC LBAM fact sheet 2012
Zalom, F. LBAM Biology. California Ornamental Research Federation

Pest Fact Sheet
Oriental Fruit Moth

Identification

Oriental fruit moth eggs are laid on the upper surface of leaves; new shoots are preferred. The eggs are small (6mm) and circular or oval-shaped. They are a translucent white progressing to a yellow/orange over a period of 1-2 weeks, depending on temperature. Larvae are creamy pink with a black head, and range from 1.5mm to 12mm long. They are similar to codling moth larvae, but oriental fruit moth have a distinctive anal comb (look on the underside of the last body segment). When the larvae mature they leave the terminal leaves or fruit on which they have been feeding to find a suitable place to pupate.

Pupation occurs in cocoons on lower parts of the trunk or in surrounding plant debris. The emerging adult moths are mottled grey (without the brown on wing tips found in codling moth). Wingspan can reach 13mm.

Oriental Fruit Moth damage on young shoots

Damage

Larvae prefer new shoots and young leaves, so this is where damage is first seen. The larvae enter the shoot tips and burrow down which causes shoot wilting and dieback, and can impact on tree development (especially when trees are young). As fruit develop larvae can sometimes enter and feed on green fruit, but it is more likely that ripening fruit will be infested. This occurs more easily when the weather is damp, and consequently fruit damage associated with oriental fruit moth can lead to fungal infections.

Life Cycle

Oriental fruit moths can have several generations each year, depending on the weather. Adults emerge in spring prior to bloom and begin to lay eggs within 7-10 days. Each female can lay up to 200 eggs. In warm conditions eggs can hatch quickly, larvae maturation and pupation can be completed in a few weeks so the life cycle can repeat several times in a season. Any larvae present as the weather cools in autumn can overwinter in cocoons.

Oriental Fruit Moth is a pest of concern to;
Philippines

Monitoring and control

Monitoring for oriental fruit moth is recommended, even though it is not a well-known pest of cherries and is rarely a pest when an insecticide program is in place. Most insecticides targeted at leaf rollers will suppress other moth pests such as oriental fruit moth. Refer to the export manual spray guide. Pheromone disruption is a potential option.

Oriental Fruit moth larva (above) and adult moth (below)

References

Cornell factsheet nysipm.cornell.edu/factsheets/treefruit

Han, K. S., Jung, J. K., Choi, K. H., Lee, S. W. & Boo, K. S. 2001. Sex Pheromone Composition and Male Trapping of The Oriental Fruit Moth, Grapholita molesta (Lepidoptera: Tortricidae) in Korea. Journal of Asia-Pacific Entomology, 4, 31-35.

Hogmire, H. & Beavers, S. 1998 Fruit Insect focus – OFM. West Virginia University

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http://extension.psu.edu/plants/tree-fruit/insects-mites/factsheets

Wsu media release – Monitoring required for export

Yang, C. Y., Han, K. S., Jung, J. K., Boo, K. S. & Yiem, M. S. 2003. Control of the Oriental Fruit Moth, Grapholita molesta (Busck) (Lepidoptera: Tortricidae) by Mating Disruption with Sex Pheromone in Pear Orchards. Journal of Asia-Pacific Entomology, 6, 97-104.

Horticulture Australia

Tasmanian Institute of Agriculture

Pest Fact Sheet Aphids

Identification

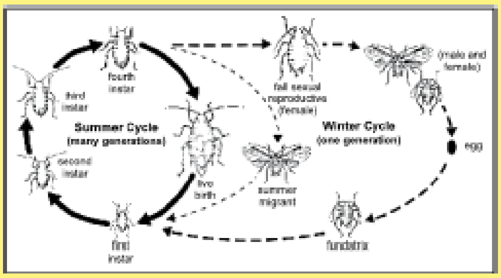
The two black aphids (black cherry and black peach) are difficult to tell apart however the black peach aphid is not likely to infest cherry trees but may infest stone fruit trees (the black cherry aphid is the only dark-coloured aphid known to attack cherry trees). The adult aphids are both dark and about 2mm in size. The nymphs are slightly different; the black cherry aphid nymphs have been described as dark brown to black, with the black peach aphid described as reddish brown to brown. Both aphids have shiny black oval eggs usually found on the underside of leaves, on buds and bark.

Life Cycle

Black cherry aphid eggs hatch just before bud burst in spring. During spring and early summer there can be several generations feeding on new leaves. Generally aphids (black cherry and black peach) will not be seen after mid-summer, when winged adults migrate to summer host plants (plants from the mustard family). Black cherry aphid eggs can remain (overwinter) on bark or buds ready to hatch in the next spring. The black peach aphid overwinters on roots of host trees (peach and related trees).

Damage

Both the black cherry aphid and the black peach aphid cause similar damage symptoms on fruit trees. Aphids often inhabit terminal leaf shoots, particularly when leaves are young and just emerging. Damage at this time includes leaves that curl inwards, and the presence of a sweet 'honeydew' secretion within the curled leaves and extending into lower leaves. The honeydew secretion can additionally cause fungal problems. Also if aphid infestation is severe leaves may brown and drop. Under these conditions fruit may decay, develop with abnormalities or with a reduction in size.



General life-cycle of aphids (above) and black cherry aphid adults and nymphs (right)

Aphids are pests of concern
Black Cherry Aphid - **China**
Black Peach Aphid – **China, Korea**

Monitoring and control

It is essential to examine trees (especially terminal leaf tips) regularly during and shortly after bud break for the presence of aphids. During this short period monitoring at least twice weekly is recommended. Once leaf-curl damage has occurred it will become more difficult to control numbers. To meet some export protocols it may be required to continue monitoring each fortnight until harvest (see export manual).

A good winter program (oil sprays before bud burst) will help prevent infestation, and aphids have a number of natural enemies – such as ladybirds. Should infestation occur, there are chemical options available in Australia for use in sweet cherry orchards. Refer to the export manual spray program guide and bear in mind that some chemicals may harm natural enemy populations. Also – it may not be necessary to spray entire blocks; look out for hot spots and treat them.

References

Green Peach Aphid; daff.qld.gov.au
Pest notes; University of California
Rnaudov, V. A. & Kolev, K. K. 2009. Susceptibility of Some Introduced Sweet Cherry Cultivars to the Attacks of Black Cherry Aphids Myzus cerasi Fab. (Homoptera: Aphididae). In: ZHIVONDOV, A., Gercheva, P. & Koumanov, K. (eds.) I Balkan Symposium on Fruit Growing.
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Lo, P. L., Mclaren, G. F. & Walker, J. T. S. 2000. Developments in pest management for integrated fruit production of stonefruit in New Zealand. In: MULLER, W., POLESNY, F., Verheyden, C. & WebsteR, A. D. (eds.) Proceedings of the International Conference on Integrated Fruit Production. Leuven 1: International Society Horticultural Science.
{Penvern, 2010 #78}
BCAgriculture Pest management
http://www.agf.gov.bc.ca/cropprot/tfipm/aphids.htm

Pest Fact Sheet
Weevils

Identification

Two types of weevils are important to cherry production; the Fuller's rose weevil, and the garden weevil (Vine calandra). Adults of both are about 7-8 mm long and grey to dark brown in colour. The way to distinguish between the two is to look for a v-shaped marking on the back of the weevil – if present you are looking at the garden weevil.

Weevils lay eggs in clumps and colour varies anywhere from white to black depending on age. The Fullers rose weevil eggs are often in clumps of 20-30 and look papery. Larvae of the Fullers rose weevil and the garden weevil are pale yellow, pupating after 4-11 instars. Pupae have short bristles.

Damage

Weevils do not generally damage fruit, but will sometimes feed on them, however they can lay eggs on fruit making them unmarketable. Weevils damage leaves (of both the cherry tree and weeds within the orchard) chewing leaf margins and creating a ragged edge. In some cases leaves may also have 'shot hole' symptoms.

Life Cycle

Adult weevils can be found all year, but peak levels are during summer. Adults lay eggs in plant debris, mulch or the soil and can lay up to 70 eggs over a 7 day period depending on temperature. Eggs hatch in about 2 weeks. The larvae remain in, or burrow into, the top 10cm of soil to overwinter.

After progressing through a number of instars, pupation occurs in the soil in late winter, early spring, and adult emergence occurs from spring through summer. Adults can begin laying eggs 3 weeks after emergence and continue to lay eggs over the summer period.

Garden weevil (left) and Fuller's rose weevil (right)

Weevils are pests of concern to;
Fuller's Rose Weevil – **China, Korea**
Garden Weevil – **China, Korea**

Monitoring and control

Monitoring for weevils needs to target the pupation period; shortly before and during bud burst - it may be required to continue monitoring each fortnight until harvest (see export manual).

Check soil for pupae when soil disturbance may be effective in reducing numbers. Regularly examine new leaf growth close to the ground, and weed leaves for adult leaf damage. Banded cardboard traps may be useful for monitoring and beating tree limbs will help find adult weevils moving within the tree.

Refer to the export manual for chemical control options. Dusk or night applications are recommended as weevils are active during the night. Post-harvest treatments may also be an option to prevent the use of insecticides close to harvest.

Leaf damage caused by weevils in citrus

References

Bredenhand, E., Van Hoorn, A., May, F., Ferreira, T. & Johnson, S. 2010. Evaluation of techniques for monitoring banded fruit weevil, Phlyctinus callosus (Schoenherr) (Coleoptera: Curculionidae), infestation in blueberry orchards. African Entomology, 18, 205-209.
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Logan DP, Maher BJ, Dobson SS, Connolly PG. 2008. Larval survival of Fuller's rose weevil, Naupactus cervinus, on common groundcover species in orchards of New Zealand kiwifruit. Journal of Insect Science 8:55, available online: insectscience.org/8.55
NSW DPI Pest and Disease info
Padil
http://www.padil.gov.au/
UC ipm online

Pest Fact Sheet
Mealybugs

Identification

There are several types of mealybugs in Australia. The two of concern to cherry production and export are the long-tailed mealybug and the citrophilus mealybug. In general, the adults are all soft-bodied, segmented, covered in varying levels of powdery wax (usually white) and can be up to 5mm long. The long-tailed mealybug is so named because of its distinctive long tail filaments. It has a pale body. The citrophilus mealybug in contrast has dark red body contents under the white coating, and short tail filaments. Adults live in colonies alongside eggs and nymphs (crawlers). Mealybug crawlers can be very difficult to see – a hand lens is recommended.

Damage

Mealybug damage is similar to aphid damage – they are both sap-sucking insects. Mealybugs will also secerte 'honeydew' which encourages fungal growth. Severe infestations of mealybugs can also cause leaf drop and reduced fruit growth and maturation.

Another concern with mealybugs is that they are known vectors of viruses. The grape and apple mealybug (which are not likely to be seen in Australia) are vectors for the little cherry viruses, but it is unknown whether the citropilius and long-tailed mealybugs are vectors. However, until it is shown to be otherwise mealybugs should be managed carefully.

Life Cycle

Mealybug lifecycles are generally short, varying with species from 1 to 4 months, so several generations per year are likely. Mealybug eggs are laid on the undersides of leaves in a protected spot such as in dense canopy or bunches. Egg numbers can be high. The adult female long-tailed mealybug can lay up to 200 eggs, which hatch almost immediately. The citropilius mealybug lays eggs into sacs and the eggs hatch after several days.

Nymphs (or crawlers) are usually present in spring but stay with the adult for a few days before venturing out to new leaves to feed. Once feeding the mealybug is unlikely to move. Adult mealybugs are very resilient and can overwinter in bark, plant debris, cracks and crevices in trellis or netting posts.

Mealybugs are more abundant in mild and warm conditions (optimum of 25°C) and high humidity.

Mealybugs are pests of concern to;
Citrophilus Mealybug - **Korea**
Long-tailed Mealybug - **China**

Monitoring and control

Given the number of generations that can occur each year, different stages can be present at any one time and mealybug numbers can increase rapidly when conditions are ideal. It is essential to examine trees (especially the undersides of leaves, stem bowls and other natural crevices) regularly during spring for the presence of crawlers. Crawlers are more vulnerable and easier to control with chemical treatments; adults can have a protective waxy coating. To meet some export protocols it may be required to continue monitoring each fortnight until harvest (see export manual).

A good winter program (oil sprays before bud burst) will help prevent infestation, and mealybugs have natural enemies – such as ladybirds. Should infestation occur and it is recognised quickly, there may be chemical options available in Australia for use in sweet cherry orchards. Ask your local agronomist and refer to the export manual spray program guide and bear in mind that some chemicals may harm natural enemy populations.

The citrophilus mealy bug (left) and the long-tailed mealybug (right)

References

AWRI viti notes 2011
GWRDC fact sheet – Mealybug management 2012
Hodek, I. & Honěk, A. 2009. Scale insects, mealybugs, whiteflies and psyllids (Hemiptera, Sternorrhyncha) as prey of ladybirds. Biological Control, 51, 232-243
Kansas state University Extension sheet mealy bug
United States National Collection of Scale Insects Photographs Archive, USDA Agricultural Research Service, Bugwood.org - See more at:
http://www.forestryimages.org/browse/detail.cfm?imgnum=5119056#sthash.OUDIfzCG.dpuf

Pest Fact Sheet
Scale

Identification

Scale insects can vary in size and appearance. There are 2 general forms of scale; hard-bodies and soft-bodies. Scales are usually circular, or oval- shaped, and secrete a waxy coating. Adults look like scales or shells, and are usually immobile. Females are often slightly larger than males. The immature insects (crawlers) have legs and are mobile while searching for an appropriate feeding site. They are usually pale (white to yellow/orange in colour.)
The four scale insects of concern are summarized below (adults).

Adult scale descriptions

	Colour	*Shape*	*Size*
European Brown	*Brown, reddish-brown*	*Circular - oval*	*3mm*
Oleander	*White, yellow*	*circular-oval*	*2.5mm*
Oystershell	*Dark brown, chestnut*	*oval*	*2mm*
San Jose	*Gray, brown, black*	*oval*	*1.5mm*

Life Cycle

Scale can have several lifecycles within a season; up to 3 generations for San Jose scale. Brown scale usually only has one cycle per season. Female scales can lay over 1000 eggs, depending on type, and as such populations can grow rapidly. Crawlers usually appear in spring and start feeding within a day. Crawlers are mobile within a tree, but can also be transported between trees by wind. Once feeding starts, the crawlers become less mobile, and begin to secrete a protective waxy coating. The near-mature crawlers can then overwinter and emerge as adults the following spring, once sap flow in the tree resumes.

Damage

Scale damage can be extensive. Scales can feed on leaves and twigs, and occasionally on fruit. When severe infestation occurs leaves can wilt, yellow and drop, and tree growth can become stunted. Like aphids, scale infestation can lead to the presence of a sweet 'honeydew' secretion. This secretion can additionally cause fungal problems.

Heavily infested twig

Scale are pests of concern to;
European Brown Scale - **Thailand**
Oleander Scale - **Korea**
Oystershell scale - **Thailand**
San Jose Scale - **Philippines**

Monitoring and control

Monitoring for the presence of crawlers is essential. The waxy coating excreted by scale insects makes control difficult, so control options must be targeted to the early crawler stages. Depending on scale type this may only last a few days to a week. A good winter program will help reduce numbers, and physical removal is possible but may not be practical. Chemical options are available – refer to the export manual spray guide.

Clockwise from top-left; European Brown scale, Oleander scale, Oystershell scale, San Jose scale

References

Arizona cop extension UoA factsheet AZ1248
Forest Health Protection - Colorado State University extension – fact sheet 5.513 Insect series
Hodges, G. Scale Insects. Florida Dept. of Ag guides
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Inra taxonomy fact sheets
PaDIL
http://www.padil.gov.au/
ucdavisipm, ipm.ucdavis.edu
UC IPM online

HAL
Horticulture Australia

tia
TASMANIAN INSTITUTE OF AGRICULTURE

Pest Fact Sheet
Thrips

Identification

Two thrips are listed on export protocols; Plague thrips and Western flower thrips. Both adult stages are yellow/light brown. The abdomen of the female western flower thrips has a black tip. Adult western flower thrips range from 0.9 to 1.8mm and adult plague thrips range from 0.8 to 1.3 mm long. In both the female is bigger than the male. Adult thrips have 2 pairs of wings.

Eggs are small, and often hard to spot as they can be laid in crevices, within plant tissue and within closed flower buds. Eggs hatch quickly giving rise to the larvae (nymphs). There are generally 2 active and feeding nymph stages, followed by 2 non-feeding resting or pupating stages before the adult stage. Nymphs are small, pale (white or yellow) and wingless.

Damage

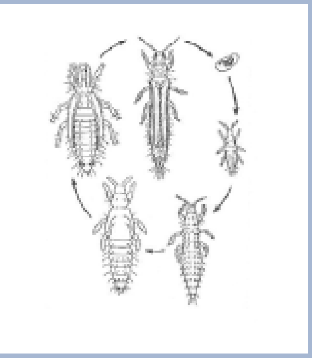
Damage from thrips occurs on buds, leaves and flowers. New growth is especially vulnerable. Thrips feed on plant tissue by inserting mouth parts (stylets), damaging tissue and accessing cellular fluids. As such, symptoms of thrips damage include distorted growth, leaf scarring, silvery tissue and malformed flowers. In addition, thrips can excrete directly onto leaf surfaces. Thrips are potential vectors for viruses.

Life Cycle

The thrips life cycle is very short – the entire cycle from egg to adult can be completed in 2 weeks.

Thrips have a life cycle that involves five stages (see diagram).
Adult - eggs - nymphs - prepupa - pupa

Female adults lay eggs from which the larval nymphs emerge after a short time – less than a week. Nymphs have two stages; nymphs are active, feeding and transmit viruses. After this nymphs either leave the tree to pupate in the soil, or remain (non-feeding) in the tree. Pupation time is also short – less than a week. Adults can overwinter in leaf or flower buds. Thrips are most active in spring while the weather is not too hot.



Thrips
life cycle

Thrips are pests of concern to;
Plague Thrips – **China, Korea**
Western Flower Thrips - **Taiwan**

Adult plague thrips (left) and western flower thrips (right)

Monitoring and control

Regular monitoring is required. For export fortnightly monitoring may be required, but to ensure thrips infestations are quickly discovered twice weekly monitoring from bud swell to petal fall is recommended. In particular check growing tips for young nymphs. Peak populations will occur in early spring. Chemical options are available – refer to the export manual and IPM calendar.

If thrips have been a problem in the past, ensure the orchard floor is clear from broad-leaved weeds. Thrips can live, feed on and overwinter on broad-leaved weeds. If weed control has not been achieved by bud swell, do not mow at this stage as thrips can move from weeds into the new tree growth.

References

Cloyd, R. Developing an Effective Western Flower Thrips Management Program Dept. Entomology Kansas State University
DoA WA Farmnote 30/93
DPI NSW 1995 Summerfruit IPDM manual
Kansas State University – fact sheets – WFT
PaDIL
http://www.padil.gov.au/pests-and-diseases

Leaf damage from thrips

Pest Fact Sheet
Native Bud Worm

Identification

The native budworm eggs are small (0.5mm) and white progressing to yellow/brown as they mature. The larvae (worms) range in size depending on age from 1.5mm up to 40mm long and vary in colour. The worms can be yellow, green, red, brown or black making identification difficult. All have a darker stripe down the back, dark heads and dark hairs coming from 'bumpy' skin.

Pupae can be up to 20-25mm long and also range in colour from yellow to brown. The adult moth has a pale brown body with a wingspan of up to 45mm; females have more vibrant forewings than males (reddish brown compared to light brown). Hind wings are pale with a dark band at the tip.

Native Budworm larvae

Damage

As the name suggests, this pest causes most damage as a worm (during the larval stage). Damage occurs to the leaves and buds when worms are feeding. New tender growth is particularly vulnerable. The adult moth feeds on nectar, but flowers are not damaged.

Life Cycle

Adult moths lay eggs in spring; each female can lay thousands of eggs over a few days. Eggs hatch within 21 days. The larvae immediately look for food, generally staying on plant surfaces. They also create silken threads with which to travel, blown by a breeze, to other trees. After a number of developmental stages occurring in as little as 3 weeks (6 weeks when cooler) larvae leave the tree to pupate.

Pupation occurs in the top 20cm of soil. If pupation commences in spring they this stage can last only 2 weeks, giving the moth time to re-emerge as an adult for a second time – 2 generations. When pupation commences later, pupae remain underground to overwinter and moths emerge again the following spring.

Native Bud Worm is a pest of concern to;
Thailand

Monitoring and control

Monitoring for bud worm needs to target the larval period; this may be anytime throughout the season – but regular monitoring will identify the emergence and early stage. Larvae that are small and still feeding in the open are most easily controlled. Continue to monitor after any treatment to check numbers and reassess. Over time, you may be able to develop a threshold for action – vegetative damage by budworm does not often cause economic or yield losses, but control may be required for export.

Check soil for pupae when soil disturbance may be effective in reducing numbers. Some natural enemies exist that will parasitise the native budworm eggs, so keep this in mind if using broad spectrum insecticides. Refer to the export manual for chemical control options.

Native Budworm Adult moth (left) and native budworms eggs (right – healthy and parasitised)

References

DAFF Qld. Helicoverpa species sheet
DEPI Vic. 1995 Native Budworm fact sheet
Gutierrez, A. P. & Ponti, L. 2013. Eradication of Invasive Species: Why the Biology Matters. Environmental Entomology, 42, 395-411

Pest Fact Sheet
Beetles

Identification

There are two beetles to take notice of in cherry orchards; the plague soldier beetle (which does not usually cause damage but is a pest of concern to China) and the Carpophilus beetle (which does cause damage and requires management).

The plague soldier beetle is soft-bodied beetle up to 15mm long; it is black with a yellow/orange abdomen and yellow/orange stripe. The carpophilus beetle is smaller, up to 5mm long and is a dull brown/black colour with club-ended antennae. The carpophilus beetle eggs are small and white and larvae are white progressing to pale yellow as they mature, with a brown head.

Damage

The plague soldier beetle is generally recognized as a 'beneficial' insect. It will not cause damage to fruit unless found in extremely high numbers. In this situation sometimes just the weight of the population may weigh down branches.

The carpophilus beetle can accumulate in large enough numbers to weigh down branches too. However, they may also damage fruit; Adults they will eat, and lay eggs in ripening fruit. Adult movement will spread rot from fruit to fruit. Early populations can damage flowers in their search for nectar.

Life Cycle

The full life cycle of the carpophilus beetle is completed in about a month. Eggs are laid in late spring in ripening fruit; larvae feed on the fruit, pupate and then emerge as adults about three weeks later. Adults can overwinter underground, under bark or in decaying or mummified fruit, emerging again in spring. They tend to be more abundant in hot, humid conditions following a wet winter.

Plague Soldier Beetle is a pest of concern to;
China

Monitoring and control

Given that carpophilus beetles do not appear until fruit is ripe, and that the plague soldier beetle does not usually cause damage, insecticide use on the crop is discouraged. Chemical control should only occur if the beetle or larvae are found; area wide treatment is recommend.

Beetle populations can be monitored using funnel traps, or by checking rotting and fallen fruit. Orchard hygiene is important as a preventative strategy as the carpophilus beetle is particularly attracted to rotting fruit.

Refer to the export manual and IPM calendar. If plague soldier beetle is observed in the orchard, ensure that pickers and the pack house are alerted to prevent any beetles entering the packing shed.

References
CSIRO Science Image http://scienceimage.csiro.au/
http://www.extension.umn.edu/

Pest Fact Sheet
Cherry Slug

Identification

Cherry slugs are the larvae of the sawfly. They are covered in a layer of dark green/black slime and look like small slugs. They can be up to 1 cm long. They do have legs (3 pairs) underneath the body but these are difficult to see.

The cherry slug (and slug damage) on cherry leaves

Damage

It is the larval stage (the slug) that damages leaves of fruit trees. Fruit are not affected. Damage from feeding initially creates small brown dots or patches but as the slugs feed on softer leaf tissue, only the leaf 'veins' remain. Usually the lower leaves are damaged first. If infestation is severe terminal growth can also be damaged. High levels of damage across the tree can reduce tree resources and impact fruit growth in the following season.

Life Cycle

The adult sawfly lays eggs on leaves throughout spring and early summer. The eggs are laid into the leaf tissue. Eggs hatch and the larvae, which look like a black slug, emerge onto the upper side of leaves in early summer. There are several stages of larval development, and the slugs can continue to feed on leaves for up to 3 weeks.
After this feeding stage and slugs are mature, the slugs drop to the ground to pupate. It is possible for 2 life cycles to be completed within one growing season. The cherry slug overwinters in the top 5-10 cm of soil as pupae in cocoons.

Cherry slug is not a pest of concern for export

Monitoring and control

Start looking for cherry slug on leaves as soon as leaves emerge. Because slugs can complete 2 lifecycles in a season it is important to catch the first generation and act as soon as possible. The physical force of a water jet will remove some slugs. Keeping other host plants to minimum (such as weeds) will also help.

There are chemical options for the control of cherry slug. Refer to the IPM calendar and export manual spray guide. Pyrethrins are effective, but keep in mind that this is a non-selective option and can reduce the number of beneficial insects. Most insecticides targeted at other pests will also suppress or control cherry slug.

Cherry slug (sawfly) pupae in cocoons (top)
Adult sawfly (middle)
And sawfly eggs (bottom)

References

NSW DPI 1995 IPDM Manual - Summerfruit
http://archive.agric.wa.gov.au/objtwr/imported_assets/content/hort/fn/pw/orchard%20alert%20issue%209%2024%20november%202010.pdf
Oregon State University fact sheet – pests of horticulture – sawfly

Pest Fact Sheet
Earwigs

Identification

Earwigs are very well known. Adults have distinctive claw-like forceps or pincers located at the end of the abdomen. Generally; male pincers are bowed while female pincers are straight. They have brown/black bodies and grow to 25mm long. Earwigs have chewing mouth parts and may or may not have wings (but rarely fly).

Earwig nymphs are grey, slightly smaller than adults and are wingless. They emerge from eggs up to 1mm long. Eggs begin as white and circular/oval but progress through to brown and can become kidney shaped.

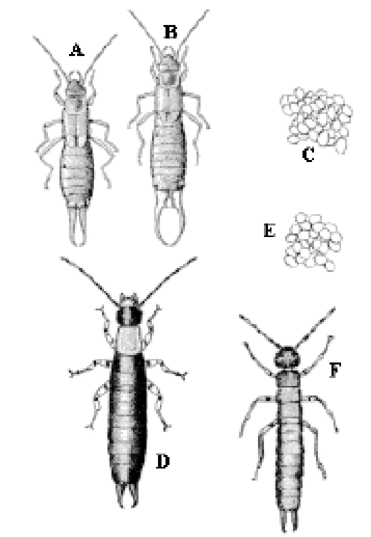
Life Cycle

Earwigs can have 2 generations per year, with numbers peaking in early spring and mid-summer.

Earwigs overwinter in plant debris or other protected places, emerging to mate and lay eggs in spring. Eggs can hatch in 2 weeks after which nymphs can feed and develop over several weeks depending on weather. Mating can occur again with more eggs laid. It is possible for eggs laid in autumn to overwinter.

Damage

Earwigs are generally beneficial insects in most crops, preying on other insects (aphids), and eggs (LBAM eggs) but they will also eat a variety of plant tissue. Feeding (and activity) is most often at night. In cherries they can be considered a pest because they can damage fruit when in high numbers.



European earwig. A, Female. B, Male. C, Eggs. Ringlegged earwig. D, Female. E, Eggs. F, Nymph.

Different stages of earwig

Earwigs are not pests of concern for export

Monitoring and control

The best way to monitor earwig populations is with cardboard traps on tree trunks. Earwigs are active at night and nest during the day in cool shady places at the base of trees. Check traps regularly from bud swell. A suggested threshold for action is 5 earwigs per trap. Use ground baits. Trees and fruit can be monitored later in the season as fruit grow bigger and provide protected nesting sites within bunches. To reduce nesting sites at the base of trees (and earwig numbers) remove mulch, weeds and pruning material from under trees when adults are likely to be present (from bud burst).

Placement of cardboard trap on tree trunk

References

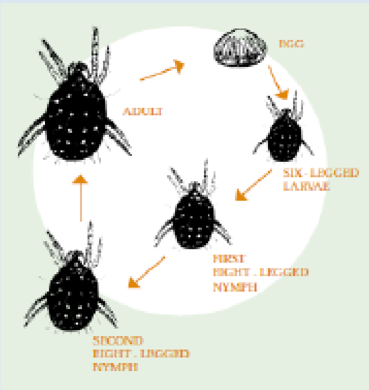
NC State University , IPM fact sheet, Earwig
http://ipm.ncsu.edu/AG268/html/earwigs.htm
NSW DPI, Integrated Pest and Disease Management for Australian Summerfruit 2005
PennState , Extension fact sheet, European earwig
Quarrell, S. 2013 Earwig fact sheet, TIA

Pest Fact Sheet
Mites

Identification

There are several types of problem mites to be aware of in cherry orchards; the twospotted spider mite, the red spider mite and the rust mite.

Mites are small (0.3-0.6mm) and difficult to spot. The spider mites are so called because they often spin protective silken webs. The twospotted spider mites are distinctive with two dark spots on each side of the body. They range from pale greenish white through to yellow/green as they mature, and can sometimes progress to a reddish colour as the season cools down. The red spider mites are red and rust mites progress from white to rust colour. Mite eggs are very small, circular and usually clear or pale yellow. Given that mites are small, a hand lens is required, or look for mite damage.



Damage

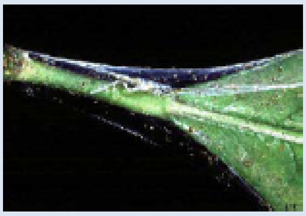
Mites have piercing mouth parts and damage plant tissue by puncturing leaves to feed. This usually occurs on the undersides of leaves and the first noticeable symptoms are pale yellow or silvery flecks on the leaf where feeding has occurred. If left, necrotic patches can develop as chlorophyll is removed. Leaf drop can occur in severe cases, and flower and leaf buds may be affected. Petal browning damage can look similar to spray burn.

Life Cycle

The full life cycle mites follows the general progression from eggs, larvae, nymph stages to adults. This cycle can occur completely within weeks during summer.

Mites are able to overwinter in protected areas, re-emerging in spring. Adult females live for up to 4 weeks and can lay many hundred eggs in that time. Eggs are often attached to webbing on the underside of leaves and can hatch within days.

Generalised mite lifecycle (left) and mite webbing on a leaf (right)



Mites are not a pest of concern

Monitoring and control

Monitoring for mites is difficult given the size of mites. They are more active in hot dry weather, and rapid increases in population can occur under such conditions. As mites do not fly, trees must be monitored. For detection a magnifying glass may be required, or tapping leaves to dislodge mites onto white paper may help to observe and identify them.

Control is best achieved if mites are identified before webbing appears and populations are large. Chemical options are available, but be aware that they may not be effective on eggs, and there are also a number of predatory mites. Predatory mites have longer legs than problem mites. There are also natural enemies of mites. Refer to the IPDM calendar and spray guide in the export manual.

Twospotted spider mites

References

Caon, G and Burfield, T. 2006 SARDI entomology fact sheet – TSM
Fasulo, T and Denmark, H. 2009 University of Florida Entomology Circular 89
Frost, B and Bailey, P. SARDI> Identifying mites on inland Australian citrus
NSW DPI 1995 IPDM manual – Summerfruit

Disease Fact Sheet
Brown rot

Identification

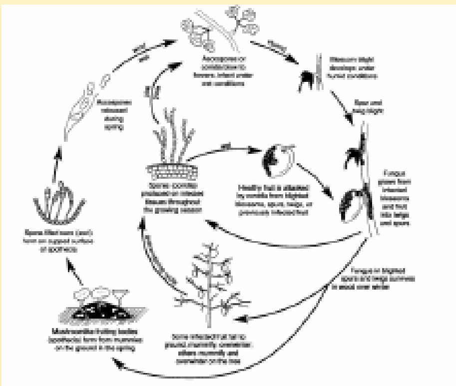
Brown rot is difficult to identify – it is hard to distinguish between brown rot (*Monilinia spp.*) and grey mould (*Botrytis cinerea*). Export markets are concerned with *Monilinia sp.*, and to make it even harder two different species of *Monilinia* appear on export lists; *Monilinia fructicola* and *Monilinia fructigena*. Monilinia laxa can also be found in Australia. The rot associated with all *Monilinia* species is similar- a pale grey/brown to brown raised 'mould'. To distinguish *Monilinia sp.* from *Botrytis* requires close microscopic examination – talk to your local service provider. To distinguish between the *Monilinia* species is even more difficult and requires diagnostic services. *Monilinia fructigena* is widespread in Europe (but has never been found in Australia) while *Monilinia fructicola and laxa* are known to be present in Australia and North America.

Damage

Brown rot can affect blossom, spurs, twigs and fruit. The greatest impact is on fruit. Infected blossom (light brown powdery spores) is a potential source of inoculum for developing fruit. Fruit can then develop without symptoms until conditions become ideal; a combination of the presence of fungi, maturing fruit and optimal weather. If weather is unusually wet post bloom green fruit may develop some symptoms such as dark lesions. Disease symptoms often start as dark lesions, expanding and progressing to tissue softening with typical rot appearance.

Life cycle

Brown rot can survive over winter in rotten or 'mummified' fruit, or in cankers on the tree. Spores from these structures (the primary source of inoculum) are released in spring and present a risk during bloom. Infection at this time can result directly in blossom blight, or enter the developing fruit and potentially develop rot symptoms in fruit closer to harvest. The development of rot involves the production of more spores (a secondary source of inoculum) which can spread to other fruit. When inoculum is present, infection occurs under suitably wet conditions. Any infected fruit left on the tree or orchard floor will add to the inoculum levels in the following year.



Typical life cycle of brown rot (Monilinia sp.)

Brown rot is a disease of concern to;
Monilinia fructicola – **China, UK/EU**
Monilinia fructigena – **Thailand**

Monitoring and control

Monitoring brown rot is required from bud burst to harvest for export to China, but it is a good idea to be vigilant for brown rot throughout the year. Orchard hygiene, and the removal of rotten fruit post-harvest, and mummified fruit over winter will reduce the potential for disease the next season. Additional monitoring during bloom is recommended, especially if the weather looks like becoming wet; this will reduce potential for disease affecting fruit later in the season. Regular ongoing monitoring will help spot any early infection on green fruit.

Cultural practices such as pruning should also promote an environment that is unattractive for disease development – aim for good airflow through the orchard. Keeping trees and fruit healthy will also reduce sites for infection to occur or spread; avoid heavy crop loads and bunching, and fruit wounding. Chemical control options are also available and will be most effective if targeted at time of possible infection; target the primary (bloom to fruit drop) and secondary (fruit ripening) inoculum stages. Refer to the IPDM calendar and the export manual.

Brown rot in sweet cherry

References

Barry, K. 2013 Brown rot fact sheet, TIA
USDA, Nomenclature fact sheets - *Monilinia*
Wilcox, W.F. Brown Rot of Stone fruits, IPM Tree Fruit Crops fact sheet, Cornell University

Disease Fact Sheet
Other

Identification

Shot hole (*Stigmina carpophila*) can be identified by the damage it causes – namely holes in leaves. This symptom can result from a number of other factors however. Twig blight (*Phytophthora syringae*) is not known to be a problem in Australia but produces small cankers in twigs. Bacterial canker (*Pseudomonas syringae pv. Morsprunorum*) produces cankers in branches and on trunks and is often identified by the gum exuded. To correctly identify any of these diseases seek advice from your local service provider.

Damage

Shothole, twig blight, and bacterial canker seemed to be named to describe the damage associated with each. Shot hole causes small brown/red spots; the 'spotted' tissue dries and degrades leaving a 'shot hole'. Severe infection may result in leaf drop as well, and brown spots (0.5-1cm) on branches and buds which can start to secrete gum. Occasionally fruit will become infected, and exhibit small circular dark spots. Twig blight causes small cankers on twigs and branches, usually low and close to the trunk union, which appear dark and sunken. Bacterial canker causes larger cankers on branches and trunks of trees. These cankers also appear dark and sunken, with tissue underneath orange/brown. Bacterial canker can also produce a clear, amber gum or resin. Infection can spread to blossom, from which cankers can develop in spurs.

Life cycle

Shot hole and twig blight are fungi. Shot hole fungi can survive the winter in buds and cankers on the tree, while twig blight fungi survive in infected roots and wood. Shot hole spores are produced in spring, twig blight spores are produced when conditions are optimal. The spores of both fungi are dispersed by rain or moisture, and shot hole spores can remain dormant on tissue for months. Under continuously wet conditions (24 hours for shot hole, 18 hours for twig blight) spores are activated and can infect tissue. Infection can occur while trees are dormant.

Bacterial canker survives on the surface of trees, in wood and buds. As such infection can occur at any time there is a wound, but activity is greatest as temperatures cool in autumn. Risk of infection is then high during leaf fall (and associated scarring) and pruning. Gummosis is also a source of infection.

Shot hole symptoms on a peach leaf

The following are of concern to;
Bacterial Canker – **China**
Twig blight – **China**
Shot hole - **Korea**

Twig blight in crab apple (above) exposing infected and clean tissue, and bacterial canker in cherry (below)

Monitoring and control

Regular monitoring is required for disease, however many preventative actions are routinely undertaken to ensure minimal disease incidence. Removal of infected tissue should be undertaken during dormancy to reduce the risk of disease in the growing season. Protective chemical options are available early in the growing season, and post-harvest.

Refer to the cherry IPDM calendar and the export manual for further information.

References

Pscheidt, J.W., and Ocamb, C.M. (Senior Eds.). 2014. Pacific Northwest Plant Disease Management Handbook.
SARDI, Pest s and Diseases – Shothole
http://www.sardi.sa.gov.au/pestsdiseases/horticulture/horticultural_crops/apricot_pests__and__diseases/shothole
Spotts. R.A., Olsen, J., Long, L., Pscheidt, J.W. 2010 Bacterial canker of sweet cherry in Oregon.
UTAH State University, Shothole Blight fact sheet

Appendix E

The National Development Program for the Australian Cherry Industry Update August 2013 presented at the National Conference in Canberra and Tasmanian, Western Australian, South Australian, News South Wales and Victorian growers.

National Development Program

The Australian Cherry Strategic Investment Plan 2012-2017 sets the objective "To ensure the Australian cherry **industry** has appropriate and sufficient capacity to manage change and industry expansion"

- Four years 2013 – 2017 (with review)
- Developed in consultation with
  - CGA Board
  - States
  - R&D committee
  - HAL
- Industry determined Regional and National issues
- Collaborative
- Co-ordinated
- A 'vehicle' for delivery of extension

Communications and extension material –

Michele Buntain (IDO) with input from TIA team and Penny Domeney as consultant

Cherry FACT SHEETS

CGA Newsletter

National cherry levy payers meetings and conferences, national extension campaigns and Fruit Growers Tasmania annual conference and night time seminars

National Development Program

Hurdles;

- That this project was not worth the $
  - $200K over 4 years
  - A lot of in-kind (and kind!)
- That the program was approved without consulting every individual grower
  - Normal approval process, with additional consultation prior to submission
- That R&D outcomes of projects were not being communicated
  - ?
- That researchers were determining what was best for the industry
  - A method only – industry determined direction

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National Development Program

Aims for 2013

1. To introduce the program to growers in each state
   - Australian Cherries (August)
   - CGA Levy-payers' meeting (August)
   - VCA AGM (October)
   - FGT Seminar Night (November)
   - Fruitwest article (Summer edition)
2. To visit each state in some capacity
   - Yes – later!
3. To ask each state to consider the needs of their industry
   - Feedback request coming soon!

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National Development Program

Extension type/topic will be determined by the grower bodies (state associations) during the previous season with the aim being on developing skills that enhance fruit quality such that these skills will be adopted and support Industry development.

Example activities and topics

- Workshops, grower discussions, technical presentations, field/orchard* walks
- Marketing, quality required for export, new challenges in management regulations, the science behind techniques, new services or systems that can be accessed (e.g. climate forecasting, setting priorities and making decisions quickly on a practical level, conducting risk analyses to aid decision making), practical outcomes of particular techniques in orchards

*consultant

National Development Program

National Development Program

- July 2013 start
  - Not much time to develop priorities – responsive to immediate industry need
- Activities to date
  - Introduction of program at levy-payers meeting (Aug, Canberra)
  - China protocol crop monitoring workshops (NSW, VIC, TAS, SA)
  - Overview of Cherry Symposium (VIC)
  - Fruit Set, Cracking and Brown Rot R&D presentation (SA)
  - Field walk, Chilling and R&D Q&A (WA)

Ben Darbyshire in Kirup, WA.
First PhD in Ag Sci 1967!

"Factors influencing the susceptibility of apple trees to *Trametes versicolour*"

Chill and R&D

Dr Penny Measham
Tasmanian Institute of Agriculture

Horticulture Australia

TASMANIAN INSTITUTE OF AGRICULTURE

What is rotting your fruit?

Managing pre-harvest rot in sweet cherry

Dr Karen Barry

13th September 2013
South Australian Cherry Growers Assoc.

UTAS

TIA is a joint venture of the University of Tasmania and the Tasmanian Government

Tasmania

TASMANIAN INSTITUTE OF AGRICULTURE

HAI

Cherry R&D

The TIA Perennial Horticulture Centre Cherry R&D Team:
Dugald Close, Sally Bound, Karen Barry, Nigel Swarts,
Jo Jones, Penny Measham, Michele Buntain,
Justin Direen, Steve Paterson

Penny Measham
13/09/2013
South Australia Cherry Growers Association

UTAS

TIA is a joint venture of the University of Tasmania and the Tasmanian Government

Tasmania

ISHS
International Cherry Symposium
2013

7th cherry international SIMPOSIUM

tia
TASMANIAN INSTITUTE OF AGRICULTURE

IHC 2014 Brisbane

Attendance and presentation at the symposium has been funded by HAL using voluntary contribution, matched funds from the Australian Government

UTAS

TIA is a joint venture of the University of Tasmania and the Tasmanian Government

Tasmania

Monitoring of pests and diseases Export to China

2013

Workshop

National Development Program

July 2013 start
Not much time to develop priorities – responsive to immediate industry need

Start thinking

What happens now?
Aim for 2014 onwards – July/August event

Next steps:
Engage a consultant
Over to you...............

Yell it out!

National Development Program

Evaluation Criteria
Quotations will be evaluated against the following criteria:

Criteria (Essential)

1. Knowledge of a variety of current cherry orchard management practices in Australia and internationally, and an ability to practically demonstrate such knowledge (20%)
2. Demonstrated capacity to work consultatively with a diversity of stakeholders and expert groups, and to provide solutions, advice and recommendations. (20%)
3. Experience in providing practical advice and understanding of tree responses to management practices (15%)
4. Demonstrated capacity to coordinate and deliver field-based activities to a variety of stakeholders (15%)
5. Demonstrated capacity to respond to client priorities in developing extension projects (15%)
6. Value for money. (15%)

Criteria (Desirable)

1. An understanding of the Australian Cherry Industry regions, regional challenges, and common national challenges and strengths
2. An understanding of the Australian Cherry Industry in the global context

National Development Program

Feedback, participation, hosting...........

2013	Oct - Nov	National coordinator and state-based regional coordinators to review list of future topics and presenters, Consultant tender released
2013	Nov	National coordinator to develop and submit milestone report
2013	Nov-Dec	Provide State Associations with a potential list of topics for the next extension event
2013 -2014	Nov - Jan	Regional coordinators liaise with industry members and State association regarding priorities
2014	Jan	Collate feedback from States
2014	March	Draft program developed in consultation with program team, consultant and R&D committee
2014	April	Finalise program and commence publicising
2014	April	National coordinator to develop and submit milestone report
2014	May-July	Extension activities (Orchard activity, presentations and discussions) undertaken in 5 states and distribute survey
2014	July	'On the day' evaluations of events from state reps forwarded to national coordinator
2014	August	Regional coordinators to prompt survey responses
2014	Sept	Evaluation from individual growers/State Associations /regional coordinators to national coordinator
2014	Sept	Round-table follow-up workshop with growers in each state

Tasmanian Institute of Agriculture – research • development • extension • education • training

National Development Program

- Discussion/Questions?
- Contact me
- Contact Tas Co-ordinator
  - Phil Pyke, fgt

Dr. Penny Measham
Tree Physiology Research Fellow
Perennial Horticulture Centre
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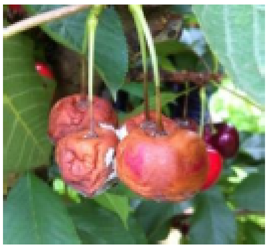
Appendix F – Information pamphlet presentation by Dr Karen Barry



Management of fruit rot in sweet cherry, prevention is better than cure!

Dr Karen Barry, Perennial Horticulture Centre, TIA

Cherry rot is a concern to most cherry growers, especially those in wetter areas, but there are many gaps in knowledge, including what the main pathogens are that currently cause disease in different regions.

What are the pathogens?

Results of a recent study in Tasmania emphasized the fact that grey mould (*Botrytis cinerea*) can play a large role in pre-harvest rot, in addition to the usual culprit brown rot (*Monilinia fructicola* and *Monilinia laxa*). During the 2011-2012 season, honours student Michael Tarbath (supervised by Dr Karen Barry and Dr Penny Measham) completed a study in a commercial, conventionally managed sweet cherry orchard in southern Tasmania. As shown in the table below, the great majority of fruit demonstrating rot symptoms at harvest were infected with *B. cinerea* (grey mould), with **no evidence** of disease caused by either *M. fructicola* or *M. laxa* (brown rot pathogens). This has significant implications for management.

Fungal Infection Type	% Pathogen Recovery	
	Cracked Fruit	Non-Cracked Fruit
B. cinerea	95.7 ± 2.8	93.9 ± 3.2
Alternaria sp.	1.7 ±1.2	3.5 ±2.7
Aureobasidium sp.	0.9 ±0.9	1.7 ±1.2
Cladosporium sp.	0.0 ±0.0	0.0 ±0.0
Monilinia sp.	0.0 ±0.0	0.0 ±0.0
Other	0.0 ±0.0	0.0 ±0.0

These results and others related to host factors can be found in the final report of HAL project CY11012.

How and when do they infect?

The brown rot and grey mould pathogens infect cherries in a similar way – with the inoculum (called conidia) infecting the susceptible blossoms and then the developing fruit. The inoculum could come from mummies or cankers in the tree from the previous season or (less likely) from fruit on the orchard floor. The infections then remain "latent" and rot only develops as the fruit mature (when the antifungal compounds present in green fruit are reduced and sugars increased). Fruit drop is another time when infections may peak. These fruit (especially when they don't abscise) can become rotten and then provide inoculum to infect other fruit. Based on studies from elsewhere, the brown rot conidia need a minimum of 6 hours of wetness to infect, while the grey mould may need as little as 4 hours of wetness.

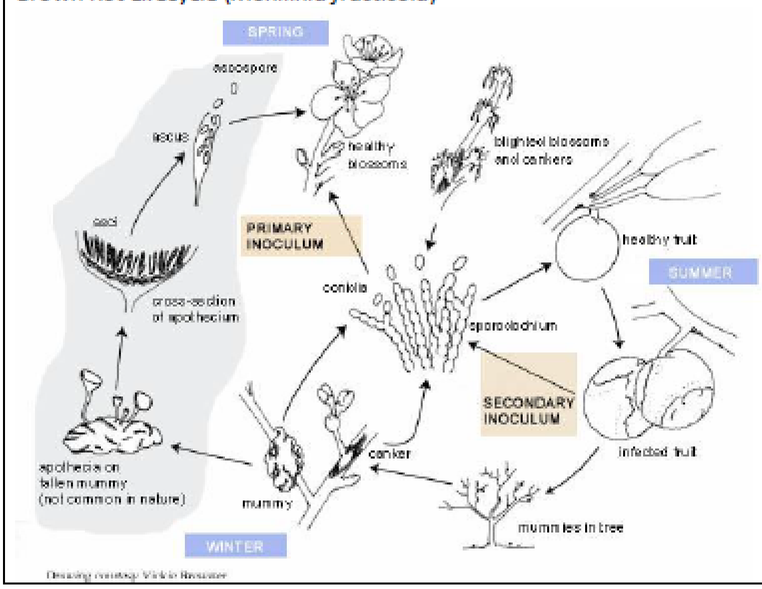
Integrated management

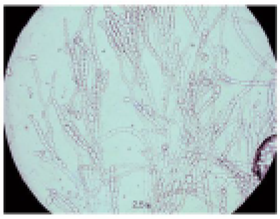
The fundamentals of integrated disease management for rot include monitoring for inoculum and disease, as well as cultural, biological and chemical control (see the CGA/TIA IPM calendar for Cherries: http://www.cherrygrowers.org.au/assets/IPM_Calendar_2013.pdf). Cultural controls include removing inoculum such as mummies, avoiding extended canopy wetness and controlling insects which damage fruit or spread spores. Some successful trials have also been undertaken in biological controls using *Trichoderma* species.

While a range of fungicides are available for control of rot in Australia, no new products have been introduced recently. For some export destinations the use of several products is restricted to petal fall. Maximum residue limits regulate usage, especially the withholding period, due to concerns for environmental and human health. Mode of action is classed by groups, and those with an "M" group reflect that the fungicide has multiple sites of action on the pathogen and resistance is less likely to develop. Those with single-sites of action are more prone to the development of resistance by the pathogens, for example in Australia, variable responses of *M. fructicola isolates* from summerfruit and canning peaches, nectarines and plum has been found to propiconazole and iprodione, suggesting potential for development of resistant populations. *Botrytis cinerea* has also been reported to show resistance to some products (in other crops) in Australia. The extent of fungicide resistance of pathogen populations found in cherry orchards in Australia is unknown.

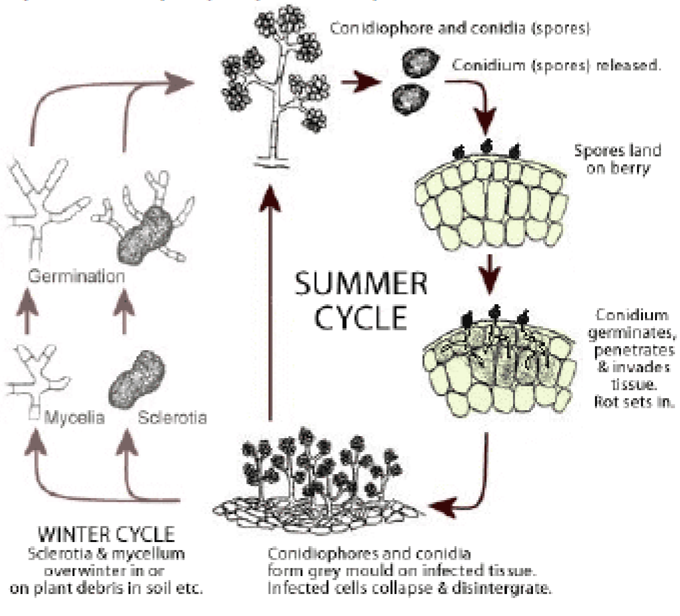
Active ingredient	Brand names	Group
Captan	Captan WG	M4
Chlorothalonil	Bravo720	M5
Dithianon	Delan	M9
Iprodione	Rovral Aquaflow	2
Mancozeb	Penncozeb	M3
Procymidone	Sumisclex/Fortress	2
Propiconazole	Tilt/Tyrant	3
Thiram	Thiragranz	M3
Ziram	Ziram	M3
Sulphur	Sulphur	M1

Brown Rot Lifecycle (*Monilinia fructicola*)





Grey Mould Lifecycle (*Botrytis cinerea*)



A new tool

Several "reduced risk" fungicides have been used in the USA for around 10 years and many are just as effective at controlling fruit rot as the traditional fungicides. Due to the reduced risk to the environment and consumers, they can be used closer to harvest. The good news for Australian cherry growers is that one reduced-risk fungicide (Pristine) which is effective for both brown rot and grey mould is now available via a minor use permit. The product is a combination of two active ingredients, boscalid and pyraclostrobin. These are both single-site activity fungicides therefore use of Pristine is restricted to three applications during the season and it should not be used consecutively, but alternatively with other products. There are reports of pathogen resistance developing to these fungicides already in the USA, so adherence to the permits is essential.

New research on the way

To fill knowledge gaps about pre-harvest rot in sweet cherry in Australia, a new 3-year HAL project is starting this year. This will investigate weather-based infection risk (laboratory based) on a range of varieties and at different stages of fruit development. Infection incidence over time will be determined at field sites in Tasmania and NSW. To confirm identity of the main pathogens causing cherry rot, surveys will be conducted at harvest in Tasmania and NSW. Knowledge gained will help growers to better target the right pathogens at the right time.

Project contacts

The project is being led by Tasmanian Institute of Agriculture (Dr Karen Barry, Dr Morag Glen and Dr Ross Corkrey) in collaboration with NSW DPI (Kevin Dodds and Dr Len Tesoriero).

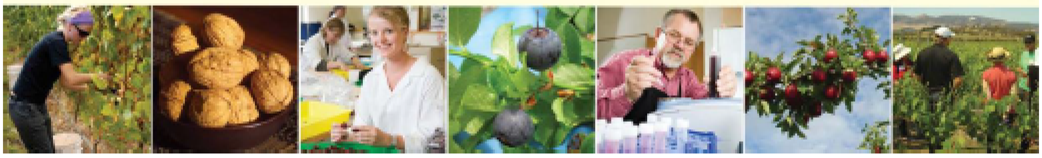
For more information, please contact Dr Karen Barry, Karen.Barry@utas.edu.au

CY11012 and CY13001: These projects have been funded by Horticulture Australia using the cherry industry levy and matched funds from the Australian government.

Horticulture Australia

CHERRY GROWERS AUSTRALIA INC

UTAS   TIA is a joint venture of the University of Tasmania and the Tasmanian Government   Tasmania



Appendix G - -Integrated Pest and Disease (IPDM) Calendar 2014

Calender can be accessed at: < http://www.utas.edu.au/__data/assets/pdf_file/0007/678940/IPM2014_Final.pdf>

IPDM Calendar for Cherries 2014

*- Commence monitoring from bud burst (see over)

Crop stages: 100% LEAF FALL | DORMANCY | BUDSWELL | * BUD BURST | FLOWERING | SHUCK FALL | SHOOT AND FRUIT DEVELOPMENT | HARVEST | POST HARVEST

Pest / disease	Activity	Actions (in calendar order)
QFF	MONITORING	Hang fruit fly traps in orchard and check frequently (fortnightly for export); And - Check fruit for stings
	CULTURAL	Remove alternative fruit sources – clean up rotting fruit; Remove rotting and fallen fruit, keep orchard floor clear
	BIOLOGICAL	
	CHEMICAL	Low pressure ; use bait sprays at 7-10 day intervals from first sighting. High pressure ; use bait sprays at 7-10 day intervals all season
MFF	MONITORING	Hang fruit fly traps in orchard and check frequently (fortnightly for export); And - Check fruit for stings
	CULTURAL	Remove alternative fruit sources – clean up rotting fruit; Remove rotting and fallen fruit, keep orchard floor clear
	BIOLOGICAL	
	CHEMICAL	Low pressure ; use bait sprays at 7-10 day intervals from first sighting. High pressure ; use bait sprays at 7-10 day intervals all season
LIGHT BROWN APPLE MOTH	MONITORING	Hang traps in orchard and check frequently (weekly or fortnightly – depending on export destination)
	CULTURAL	Keep weeds down, and remove pruning waste; Keep weeds down to reduce the number of overwintering sites
	BIOLOGICAL	Place pheromone traps in orchard; Encourage parasitic & predatory insects, consider Trichogramma wasps
	CHEMICAL	Match control to egg hatching, use date of first trap catch as a guide, selective insecticides available
CODLING MOTH	MONITORING	Hang traps in orchard and check frequently (weekly or fortnightly – depending on export destination)
	CULTURAL	Keep weeds down, and remove pruning waste; Keep weeds down to reduce the number of overwintering sites
	BIOLOGICAL	Place pheromone traps in orchard
	CHEMICAL	Match control to egg hatching, use date of first trap catch as a guide
ORIENTAL FRUIT MOTH	MONITORING	Hang traps in orchard and check frequently (weekly or fortnightly – depending on export destination)
	CULTURAL	Keep weeds down, and remove pruning waste; Keep weeds down to reduce the number of overwintering sites
	BIOLOGICAL	Place pheromone traps in orchard
	CHEMICAL	Most insecticides targeted at other moths will control other moth pests
APHIDS	MONITORING	Check growing tips regularly, especially early in the season
	CULTURAL	Minimise excessive vegetative growth and physically remove colonies if small scale infestation occurs
	BIOLOGICAL	Encourage parasitic and predatory insects with nectar-producing plants within orchard, headlands and windbreaks
	CHEMICAL	Apply winter oil; Spray 'hot spots' early, or apply to blocks if necessary
WEEVILS	MONITORING	Check soil for pupae; Check trees for beetles, consider using banded cardboard traps
	CULTURAL	Keep weeds and plant debris to a minimum, consider soil disruption if pupae spotted; Remove mulch from under trees, control weeds and consider removing low branches
	BIOLOGICAL	Consider using poultry to control weevils under trees (small scale only)
	CHEMICAL	Consider dusk applications of insecticide (trunk sprays) if heavy infestations occur
MEALYBUG	MONITORING	Check trees regularly for mealybug crawlers, check undersides of leaves, and stem bowls
	CULTURAL	Keep weeds and plant debris to a minimum; Minimise movement of leaf material
	BIOLOGICAL	Encourage parasitic and predatory insects with nectar-producing plants within orchard, headlands and windbreaks
	CHEMICAL	Apply winter oil; Most insecticides targeted at aphids will also suppress or control mealy bug
SCALE	MONITORING	Check trees regularly for crawlers, especially early in the season
	CULTURAL	Keep weeds and plant debris to a minimum; Physical removal possible if small scale infestation occurs; Minimise movement of leaf material
	BIOLOGICAL	
	CHEMICAL	Apply winter oil; Most insecticides targeted at other pests may also suppress or control scale
THRIPS	MONITORING	Check growing tips regularly, especially early in the season. Traps can be used.
	CULTURAL	Keep weeds down; Keep weeds down to reduce the number of overwintering sites
	BIOLOGICAL	Encourage parasitic and predatory insects with nectar-producing plants within orchard, headlands and windbreaks
	CHEMICAL	Apply 3 consecutive sprays if thrips present, keep monitoring and use insecticide with alternative mode of action if thrips return
NATIVE BUDWORM	MONITORING	Check soil for pupae; Check buds and growing tips early in the season for bud worm, continue checking trees throughout the season
	CULTURAL	Keep weeds and plant debris to a minimum, consider soil disruption if pupae spotted
	BIOLOGICAL	Encourage parasitic and predatory insects with nectar-producing plants within orchard, headlands and windbreaks
	CHEMICAL	Most insecticides targeted at leaf rollers will suppress other moth pests
BEETLES	MONITORING	Check trees for beetles (funnel traps could be used)
	CULTURAL	Remove alternative fruit sources – clean up rotting fruit; Remove rotting and fallen fruit, keep orchard floor clear
	BIOLOGICAL	
	CHEMICAL	Insecticide use if not necessary unless populations are very high
CHERRY SLUG	MONITORING	Check soil for pupae; Check trees for slug damage regularly, try and catch the first emergence early in the season
	CULTURAL	Keep weeds and plant debris to a minimum, consider soil disruption if pupae spotted
	BIOLOGICAL	Encourage parasitic and predatory insects with nectar-producing plants within orchard, headlands and windbreaks
	CHEMICAL	Apply winter oil; Most insecticides targeted at other pests will suppress or control cherry slug.
EARWIG	MONITORING	Check trees or traps for earwigs, suggested threshold is 5 earwigs per tree/trap; Monitor for fruit damage if population high
	CULTURAL	Remove mulch from under trees, control weeds and consider removing low branches
	BIOLOGICAL	Consider using poultry to control weevils under trees (small scale only)
	CHEMICAL	Apply ground baits before earwigs move up into trees.; Apply ground baits for second generation if necessary
BACTERIAL CANKER	MONITORING	Check trees for cankers to remove; Monitor trees (requirement for export to China)
	CULTURAL	Site & variety selection important, use clean graft wood; Prune out infected wood
	BIOLOGICAL	
	CHEMICAL	Apply copper at early and late dormancy; Apply copper if infection severe; Apply copper at 10% & 80% leaf fall
BROWN ROT	MONITORING	Assess risk by estimating mummified fruit numbers; Monitor trees (requirement for export to China)
	CULTURAL	Remove mummified fruit and infected twigs; Good insect control will limit spread
	BIOLOGICAL	
	CHEMICAL	Apply systemic fungicides; Apply protectant and systemic fungicides if required
TWIG BLIGHT & SHOTHOLE	MONITORING	Monitor trees (requirement for export to China)
	CULTURAL	Site & variety selection important, use clean graft wood
	BIOLOGICAL	
	CHEMICAL	Control of bacterial canker and brown rot should also supress other diseases

IPDM Calender for Cherries 2014

Fruit fly	**Mediterranean Fruit Fly**	***Ceratitis capitata***
	Queensland Fruit Fly	***Bactrocera tryoni***
	Other Fruit flies	***Bactrocera sp.***
Moth	**Codling Moth**	***Cydia pomonella***
	Light Brown Apple Moth	***Epiphyas postvittana***
	Tortricid Moth (LLBAM)	***Epiphyas xylodes***
	Oriental Fruit Moth	***Cydia molesta***
Aphid	**Black Cherry Aphid**	***Myzus cerasi***
	Black Peach Aphid	***Brachycaudus persicae***
Weevil	**Fuller's Rose Beetle/Weevil**	***Asynonychus cervinus***
	Garden Weevil (Vine calandra)	***Phlyctinus callosus***
Mealybug	**Citrophilus mealybug**	***Pseudococcus calceolariae***
	Long-tailed Mealybug	***Pseudococcus longispinus***
Scale	**European Brown Scale**	***Parthenolecanium corni***
	Oleander scale	***Aspidiotus nerii***
	Oystershell Scale	***Lepidosaphes ulmi***
	San Jose Scale	***Quadraspidiotus perniciosus***
Thrips	**Plague Thrips**	***Thrips imagines***
	Western Flower Thrips	***Frankliniella occidentalis***
Worm	**Native Bud worm**	***Helicoverpa punctigera***
Beetle	**Plague Soldier Beetle**	***Chauliognathus lugubris***

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Hobart TAS 7000

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Email: office@cherrygrowers.org.au

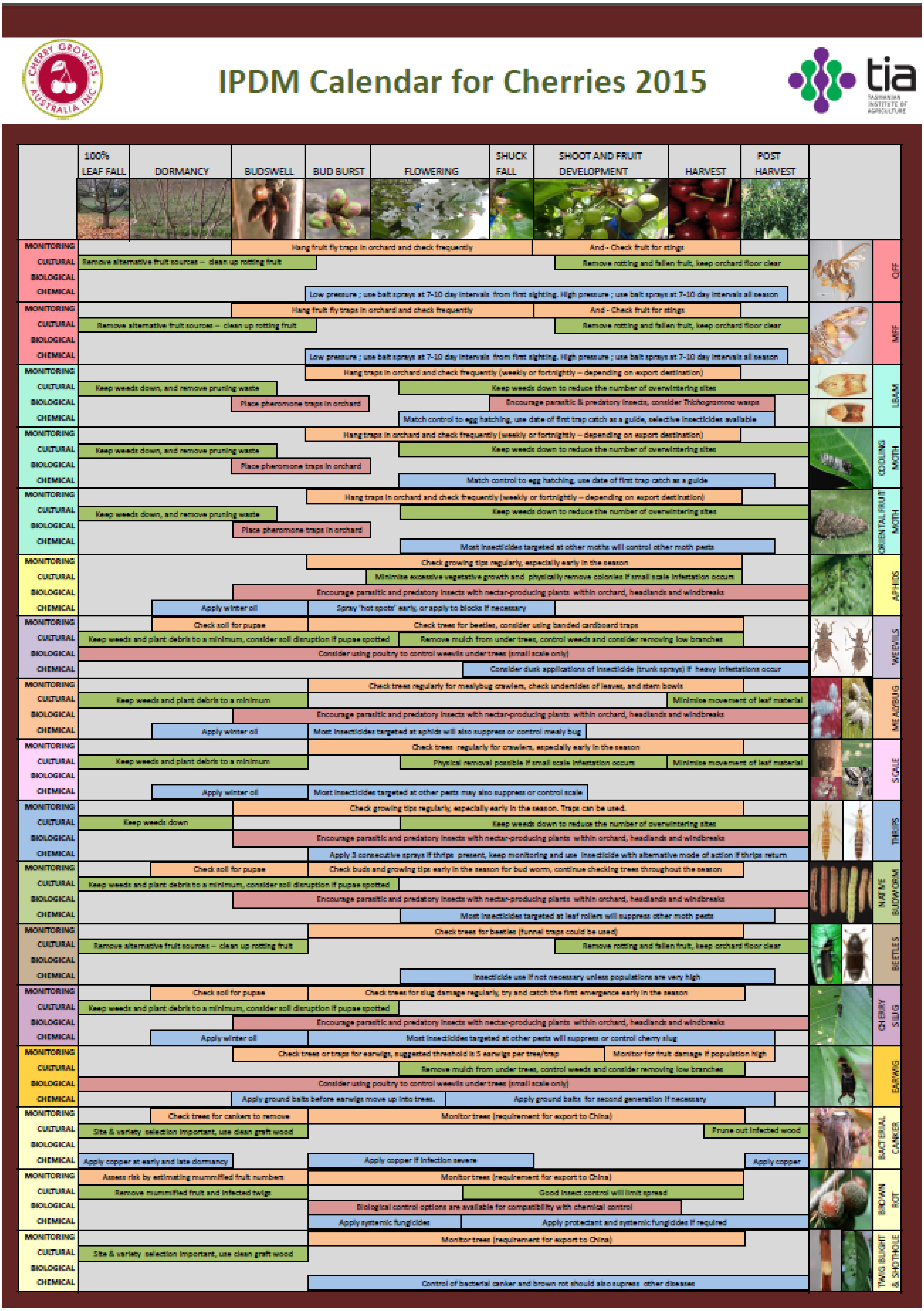
	Pests	how often?	where to look?	how many traps/trees?	threshold	Action
Fruit Fly	Mediterranean Fruit Fly Queensland Fruit Fly Other Fruit flies	fortnightly *	traps#	refer to notes	refer to notes	talk to local agency consider end point treatment options
Leaf Roller	Codling Moth Light Brown Apple Moth Torticid Moth (LLBAM) Oriental Fruit Moth	* fortnightly fortnightly fortnightly	traps and trees	refer to notes	7 moths per trap (average)	talk to local agency consider end point treatment options
Aphids	Black Cherry Aphid Black Peach Aphid	fortnightly *	buds, new growth, leaf tips	10trees per block	2 colonies per tree	refer to IPM calendar and spray program guide
Weevils	Fuller's Rose Weevil Garden Weevil	fortnightly	trees	10trees per block	50+ weevils per tree	refer to IPM calendar and spray program guide
Mealybug	Citropilus mealybug Long-tailed Mealybug	fortnightly	branch junctions, leaves, fruit stem bowls	10trees per block	No threshold set **	refer to IPM calendar and spray program guide
Scale	European Brown Scale Oleander scale Oystershell Scale San Jose Scale	fortnightly	bark, brances, fruit and leaf stems	10trees per block	No threshold set **	refer to IPM calendar and spray program guide
Thrips	Plague Thrips Western Flower Thrips	fortnightly *	buds, new growth, leaf tips	10trees per block	Presence	refer to IPM calendar and spray program guide
Worms	Native Bud worm	fortnightly	buds, new growth,	10trees per block	No threshold set	refer to IPM calendar
Beetles	Plague Soldier Beetle Carpophilus Beetle	fortnightly	trees	10trees per block	No threshold set	refer to IPM calendar alert packing shed
Cherry Slug		fortnightly	leaves	10trees per block	No threshold set	refer to IPM calendar
Earwig		fortnightly	trees	10trees per block	No threshold set	refer to IPM calendar
Pest Mites		fortnightly	trees	10trees per block	No threshold set	refer to IPM calendar

Diseases	how often?	where to look?	how many traps/trees?	threshold	Action
Bacterial canker	fortnightly*	trees	10 trees per block	No threshold set	refer to IPM calendar
Brown rot[@]		fruit	10 fruit clusters per block	**	
Twig blight		trees	10 trees per block		
Shot hole		leaves	10 trees per block		

Monitoring to commence at bud burst and results need to be recorded on monitoring sheets
*Monitoring fortnightly meets most export protocols, check specific workplans to be sure
*Monitoring for codling moth is undertaken by DPIPWE in Tasmania for export to Japan and Korea – this is done weekly to meet those protocols
* It is recommended that monitoring occur more frequently for thrips and aphids from bud swell to petal fall
#Traps for fruit fly can be specific for each type, or they can be non-specific. Talk to your supplier and check the workplan for requirements
**There is no threshold set for mealybug, scale, or any of the diseases for cherries. Keep records and notes and you may be able to set your own threshold for damage.
@ If rot is visually detected follow up with diagnostic testing to discern if it is Monolinia sp. or Botrytis sp. The type of rot will impact on treatment options available.

Integrated Pest and Disease (IPDM) Calendar 2015

Calender can be accessed at: < http://www.utas.edu.au/__data/assets/pdf_file/0007/754117/IPDM2015.pdf>



IPDM Calender for Cherries 2014

	Pests	China	Hong Kong	Japan	Korea	Philippines	Taiwan	Thailand	UK/Europe	USA
Qld Fruit Fl	Mediterranean Fruit Fly	•		•	•	•	•	•		•
	Queensland Fruit Fly	•		•	•	•	•	•		•
	Other Fruit flies									
Leaf Roller	Codling Moth			•	•	•	•			
	Light Brown Apple Mot	•			•			•		•
	Torticid Moth (LLBAM)	•			•					
	Oriental Fruit Moth					•				
Aphids	Black Cherry Aphid	•								
	Black Peach Aphid	•			•					
Weevils	Fuller's Rose Beetle/We	•			•					
	Garden Weevil (Vine cal	•			•					
Mealybug	Citropilus mealybug				•					
	Long-tailed Mealybug	•								
Scale	European Brown Scale							•		
	Oleander scale				•					
	Oystershell Scale							•		
	San Jose Scale					•				
Thrips	Plague Thrips	•			•					
	Western Flower Thrips						•			
Worms	Native Bud worm							•		
Beetles	Plague Soldier Beetle	•								
	Carpophilus Beetle									
Cherry Slug										
Earwig										
Pest Mites										
	Diseases	China	Hong Kong	Japan	Korea	Philippines	Taiwan	Thailand	UK/Europe	USA
Bacterial canker		•								
Brown Rot		•						•	•	
Twig Blight		•								
Shot hole					•					

Monitoring summary for export to China (essential)

	Pests	how often?	where to look?	how many ?	action threshold	suggested action
Fruit Fly	Mediterranean Fruit Fly Queensland Fruit Fly	fortnightly*	traps# fruit	refer to notes	refer to notes	talk to local agency consider bait sprays consider end point treatments
Leaf Roller	Light Brown Apple Moth Torticid Moth (LLBAM)	fortnightly*	traps and trees	refer to notes	3 moths per trap	target sprays to larvae emergence talk to local agency consider end point treatments
Aphids	Black Cherry Aphid Black Peach Aphid	fortnightly*	buds, new growth, leaf tips	10 trees per block	2 colonies per tree	refer to IPM calendar and spray program guide
Weevils	Fuller's Rose Weevil Garden Weevil	fortnightly	trees	10 trees per block	30+ weevils per tree	refer to IPM calendar, spray guide and alert packing shed Consider winter management
Mealybug	Long-tailed Mealybug	fortnightly	branch junctions, leaves, fruit stem bowls	10 trees per block	No threshold set	refer to IPM calendar, spray guide and alert packing shed
Thrips	Plague Thrips	fortnightly	buds, new growth, leaf tips	10 trees per block	Presence	refer to IPM calendar and spray program guide
Beetles	Plague Soldier Beetle	fortnightly	trees	10 trees per block	No threshold set	refer to IPM calendar and alert packing shed
	Diseases	**how often?**	**where to look?**	**how many?**	**action threshold**	**suggested action**
Bacterial canker Brown rot Twig blight		fortnightly*	trees fruit trees	10 trees per block 10 fruit clusters per block 10 trees per block	No threshold set action required if symptoms present	refer to IPM calendar

Additional monitoring for good practice and for export to all protocol countries

	Pests	how often?	where to look?	how many ?	action threshold	suggested action
Mealybug	Citrophilus mealybug	fortnightly	branch junctions, leaves,	10 trees per block	No threshold set **	refer to IPM calendar, spray guide and alert packing shed
Scale	European Brown Scale Oleander Scale Oystershell Scale San Jose Scale	fortnightly	bark, brances, fruit and leaf stems	10 trees per block	No threshold set **	refer to IPM calendar and spray program guide
Thrips	Western Flower Thrips	fortnightly	buds, new growth, leaf tips	10 trees per block	Presence	refer to IPM calendar and spray program guide
Worms	Native Bud Worm	fortnightly	buds, new growth,	10 trees per block	No threshold set	refer to IPM calendar
Beetles	Carpophilus Beetle	fortnightly	trees	10 trees per block	No threshold set	refer to IPM calendar and alert packing shed
Cherry Slug		fortnightly	leaves	10 trees per block	No threshold set	refer to IPM calendar and spray guide
Earwig		fortnightly	traps, fruit and trees	10 trees per block	5 earwigs per trap	refer to IPM calendar and spray guide
Pest Mites		fortnightly fortnightly	trees trees	10 trees per block 10 trees per block	No threshold set No threshold set	refer to IPM calendar and spray guide
	Diseases	**how often?**	**where to look?**	**how many?**	**action threshold**	**suggested action**
Shot hole		fortnightly*	leaves	10 trees per block	No threshold set	refer to IPM calendar

Monitoring notes

- To ensure compliance with export protocols for China fortnightly monitoring should be undertaken; some protocols require weekly monitoring
- Monitoring does not equal control
- **Absence of pests and diseases needs to be recorded – mark the monitoring sheet with an 'x' or 'no' or 'nil'**
- All countries are concerned about **fruit fly** – talk to your local agency regarding monitoring currently in place
- **All blocks registered for export must contain at least one fruit fly trap for each fly (QFF and MFF)**
- It is recommended that traps for fruit fly are consistent with the National Code of Practice where possible; Lynfield or suitable equivalent
- **If fruit fly is detected verification can be made by state agencies**
- **The action threshold for fruit fly is 'presence'.** If one fly is detected contact your local agency for advice, and consider using bait sprays
- For export to Japan and Korea from Tasmania – talk to DPIPWE regarding trapping and monitoring for codling moth
- For other states, all blocks registered for export must contain at least one trap per block for codling moth and LBAM
- Action taken in response to light brown apple moth sightings is based on Degree Day Calculations – ask for advice if needed
- Become familiar with the life cycle of pests and diseases – this will help to know when to expect an outbreak; refer to factsheets
- Longtailed mealybug is considered exotic in Australia (Plant Health Australia); it is unlikely to be found in cherry orchards – if any mealybugs are suspected talk to your local agency
- **'No threshold' on the monitoring guide does not equal 'no action';** this means there is no agreed threshold for action. Talk to your local agronomist or service provider, or use past records to develop your own threshold at which damage occurs. CGA are building a database of known pests and diseases
- **There are currently no rejection thresholds set by China; the pest and disease database will help inform decisions on damaging levels**
- **Any unusual pests should be reported immediately through the Exotic Plant Pest Hotline**

(1800 084 881).

Appendix H – Feedback Questionnaire Form provided to cherry growers in 2014.

2014 National Development Program Feedback

The objectives of the national development program (NDP) for the cherry industry are to facilitate industry communication, extension and education. Each year state and national priorities are put forward by each state (through the state representative) and the program then co-ordinates relevant activities or communication. This field day is one of the activities for 2014. Your feedback is highly valued, and will be used to inform future events. Please be honest in answering the questions below.

Thank you.

How did you hear about the event?	
Have you heard of the NDP before today?	
What was the highlight of the day?	
How could the day have been improved?	
Are there any topics (or speakers) you would like to see included in the future?	
What is the biggest issue your industry faces at the moment?	
Did you learn anything relevant or new today? If so – will you apply it to your orchard?	

Please answer the following questions with a number from 1 to 10 (with 1 being the worst and 10 being the best)

How would you rate the event overall?	
How relevant was the event to your business?	
Was the material covered clearly presented?	
Was the material covered useful?	
How well did you like the format of the day?	
How would you rate this event compared to the last grower event you attended?	

Any further comments....

Appendix I – Revised Industry Standards for export crop monitoring.

	Pests	how often?	where to look?	how many ?	action threshold	suggested action
Fruit Fly	Mediterranean Fruit Fly Queensland Fruit Fly	fortnightly*	traps# fruit	refer to notes	refer to notes	talk to local agency consider bait sprays consider end point treatments
Leaf Roller	Light Brown Apple Moth Torticid Moth (LLBAM)	fortnightly*	traps and trees	refer to notes	3 moths per trap	target sprays to larvae emergence talk to local agency consider end point treatments
Aphids	Black Cherry Aphid Black Peach Aphid	fortnightly*	buds, new growth, leaf tips	10 trees per block	2 colonies per tree	refer to IPM calendar and spray program guide
Weevils	Fuller's Rose Weevil Garden Weevil	fortnightly	trees	10 trees per block	30+ weevils per tree	refer to IPM calendar, spray guide and alert packing shed Consider winter management
Mealybug	Long-tailed Mealybug	fortnightly	branch junctions, leaves, fruit stem bowls	10 trees per block	No threshold set	refer to IPM calendar, spray guide and alert packing shed
Thrips	Plague Thrips	fortnightly	buds, new growth, leaf tips	10 trees per block	Presence	refer to IPM calendar and spray program guide
Beetles	Plague Soldier Beetle	fortnightly	trees	10 trees per block	No threshold set	refer to IPM calendar and alert packing shed
	Diseases	**how often?**	**where to look?**	**how many?**	**action threshold**	**suggested action**
Bacterial canker Brown rot Twig blight		fortnightly*	trees fruit trees	10 trees per block 10 fruit clusters per block 10 trees per block	No threshold set action required if symptoms present	refer to IPM calendar

	Pests	how often?	where to look?	how many ?	action threshold	suggested action
Mealybug	Citrophilus mealybug	fortnightly	branch junctions, leaves,	10 trees per block	No threshold set **	refer to IPM calendar, spray guide and alert packing shed
Scale	European Brown Scale Oleander Scale Oystershell Scale San Jose Scale	fortnightly	bark, brances, fruit and leaf stems	10 trees per block	No threshold set **	refer to IPM calendar and spray program guide
Thrips	Western Flower Thrips	fortnightly	buds, new growth, leaf tips	10 trees per block	Presence	refer to IPM calendar and spray program guide
Worms	Native Bud Worm	fortnightly	buds, new growth,	10 trees per block	No threshold set	refer to IPM calendar
Beetles	Carpophilus Beetle	fortnightly	trees	10 trees per block	No threshold set	refer to IPM calendar and alert packing shed
Cherry Slug		fortnightly	leaves	10 trees per block	No threshold set	refer to IPM calendar and spray guide
Earwig		fortnightly	traps, fruit and trees	10 trees per block	5 earwigs per trap	refer to IPM calendar and spray guide
Pest Mites		fortnightly fortnightly	trees trees	10 trees per block 10 trees per block	No threshold set No threshold set	refer to IPM calendar and spray guide
	Diseases	how often?	where to look?	how many?	action threshold	suggested action
Shot hole		fortnightly*	leaves	10 trees per block	No threshold set	refer to IPM calendar

Appendix J – Dr Penny Measham Victorian Cherry Grower Association Conference presentation.

Flowers to fruit; Early fruit formation and late fruit quality

Penny Measham
Ian Cover
Kieren Rix
Sally Bound

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Project
Reducing the impact of late season rainfall
CY12000

Three years

2012 – 2015

Project team

Karen Barry, Sally Bound

Research Assistance

Ian Cover, Kieren Rix

Student Involvement

Matthew Calverley, Hend Mohamed

Project
Reducing the impact of late season rainfall CY12000

CY09002 Improving marketable yield of premium quality fruit

- Mechanisms of cracking
- Assessing strategies (crop load, sprays, pruning, irrigation*)

CY12000 Objectives

1. Building resilience into fruit early (before rainfall near harvest)
   - Improve fruit integrity
   - Skin mechanical properties
2. Reducing the impact of rapid water uptake to fruit following rainfall
   - Xylem conductivity
   - Drivers of water movement
   - Improve fruit integrity

Project
Reducing the impact of late season rainfall CY12000

Building resilience into fruit

– Calcium; 5 trials, 2 years, Sweet Georgia

– Irrigation; 3 trials, 2 years, Lapins, Sweetheart

– Cytolin: 8 trials, 3 years, Lapins, Sweetheart, Sweet Georgia

– Root pruning; 2 trials, Lapins

Reducing impact of water uptake

– Ground cover; 1 trial (large), Lapins

– Root pruning; 0 trials*

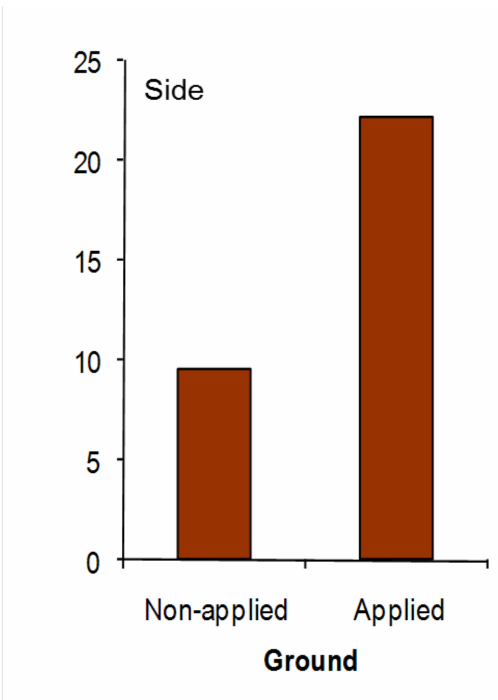
– Xylem conductivity; 2 trials, Lapins, Sweetheart

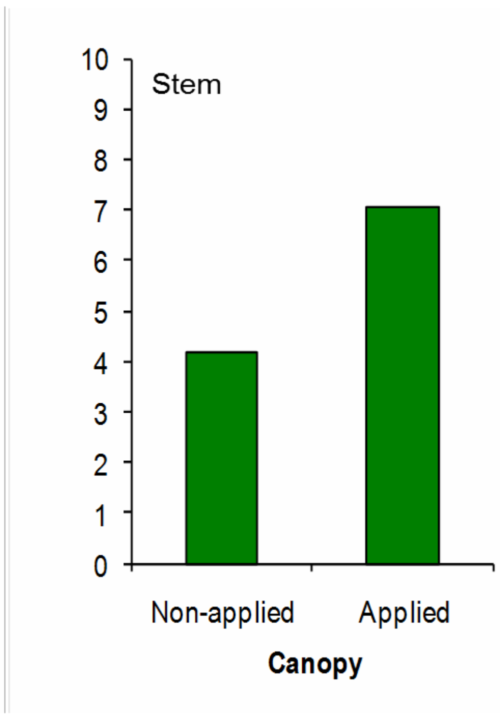
– Soil fungi; 2 trials, Colt rootstock

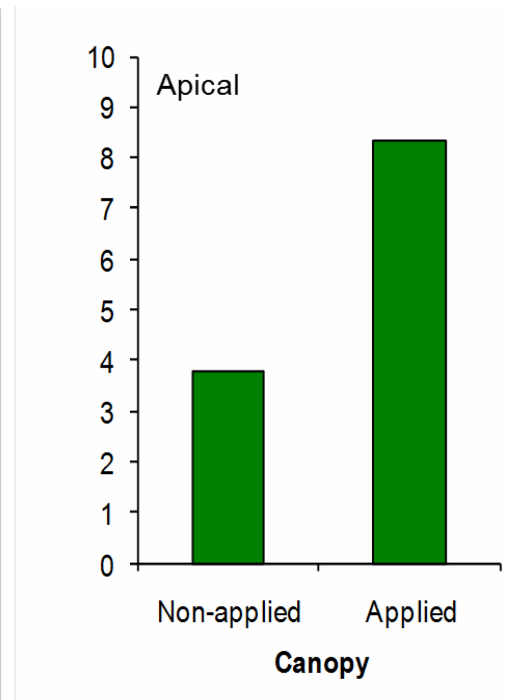
Project
Early fruit formation and mature fruit quality

Increase in side cracks with internal water movement

Increase in apical / stem cracks with wetted fruit surface



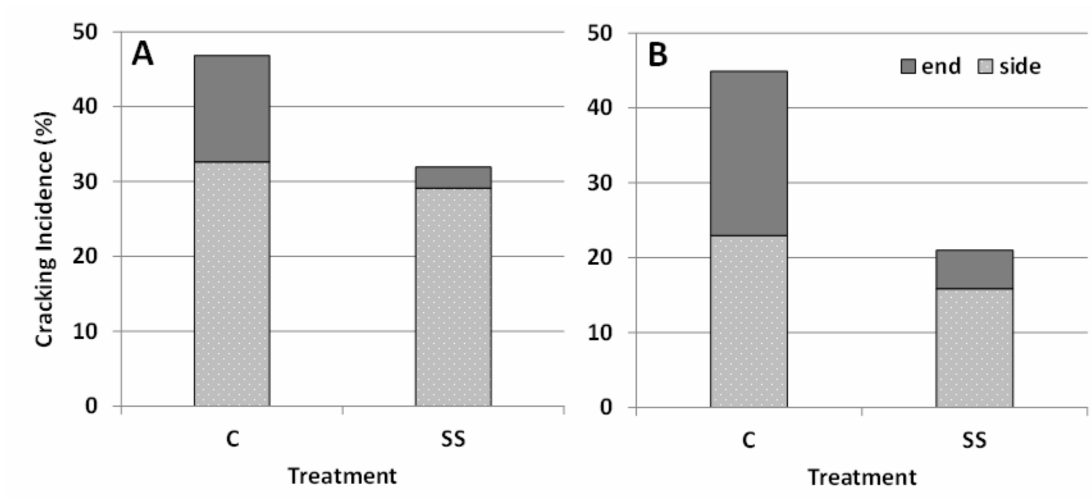




Project
Early fruit formation and mature fruit quality

Sprays

Reduce cracking
Due to impact on end cracks

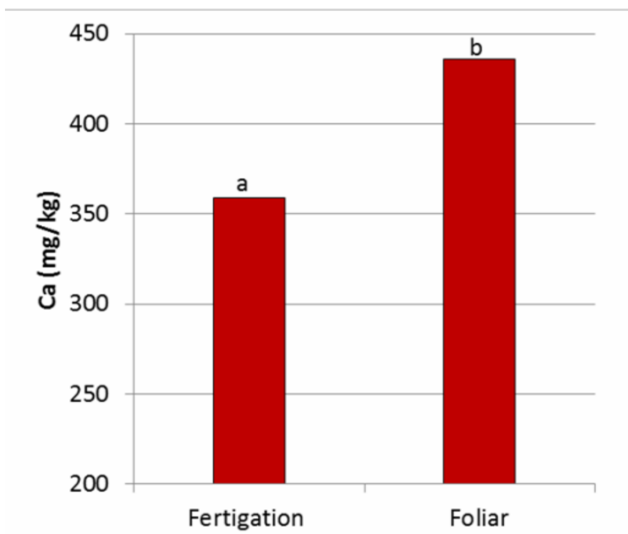


Trial	Treatment	Cracking (%)
Aust	C	8.40 a
	SS	6.64 a
Aust	C	12.44 a
	SS	6.86 b
Aust	C	43.19 a
	SS	28.04 a
Aust	C	46.85 a
	SS	31.93 b
Aust	C	44.89 a
	SS	20.99 b
USA	C	13.60 a
	P	6.03 b
USA	C	4.33 a
	P	1.75 b
Turkey	C	21.33 a
	P	12.00 b
Turkey	C	31.33 a
	P	7.16 b
Turkey	C	36.33 a
	P	29.16 b

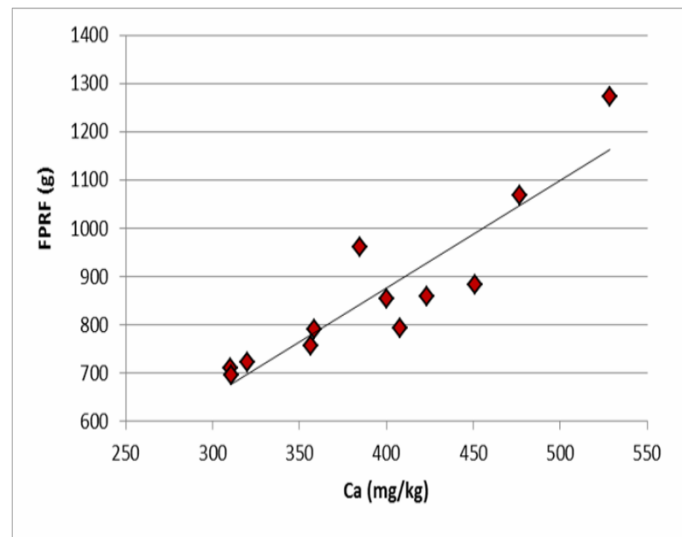
Project
Reducing the impact of late season rainfall

Nutrition

Impact on fruit skin (foliar)
Impact within fruit (fertigated)
Distribution impacts on crack types



Significant (P=0.008) difference in the skin
Fertigated 359.1, Foliar 436.2, lsd = 40



Pedicel retention positively correlated to calcium levels in the skin (R^2=0.821)

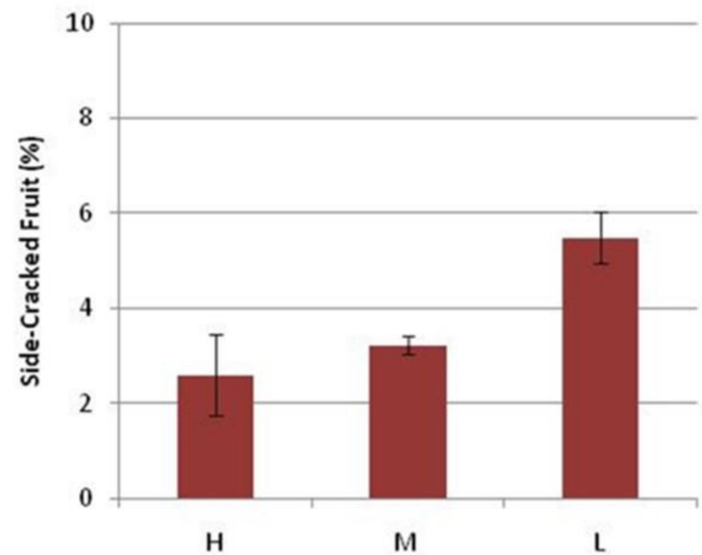
Project
Reducing the impact of late season rainfall

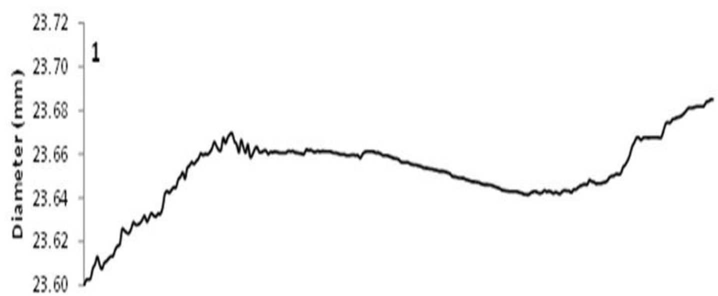
Irrigation

Impacts on side cracking

Reduce water stress

Uniform growth





Significant effect of irrigation on side cracks; low irrigation resulted in more side-cracked fruit after rainfall

Project
Early fruit formation

Apical-end scarring and crack development?

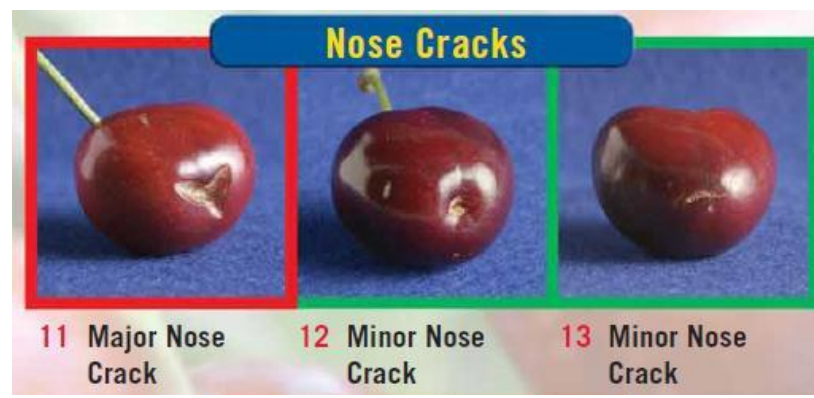
Grower concern about reduction in quality

Observations that scarring and subsequent crack development more prevalent in sites experiencing colder spring weather

Related to rate of development?

Promote floral closure and faster fruit development to reduce scar tissue

- Early fruit growth patterns?
- Harvest quality?



Project
Early fruit formation

Four sites, three years, 8 trials

– Southern Tasmania, Commercial orchards, Mature trees;
Lapins, Sweetheart, Sweet Georgia

– All sites with cool springs (Site 1 – av. Spring temp. higher)

	1	2	3	4	5	6	7	8
Site	1	2	3	2	4	2	3	1
Year	13	13	14	14	15	15	14	14
Var	L	L	L	L	L	L	SG	Sw
RF	5	8	66	24	100+	100+	51	21

Project
Early fruit formation

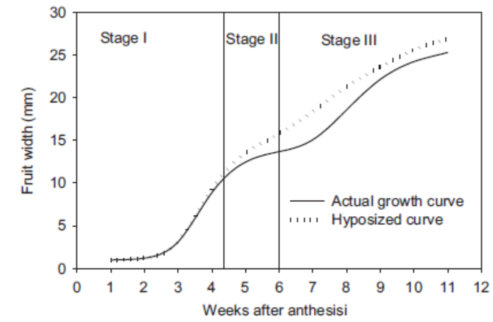
Cytolin application

Used in apples to promote development and elongation

- Cytolin; 6 – benzyladenine, GA4,7
  - Cell division
  - Cell elongation
  - Setting/thinning

- 50% 100% and petal fall @ 500ml/ha a total of 1.5lt/ha cytolin/ha
- When is the right time for application?
  - What purpose?
  - What do we know about the tree/fruit?
  - When is it feasible?

Project
Early fruit formation



When is the right time for application?

Cell division

– Cell number major contributor to size (Olmstead, Iezzoni and Whiting 2007) in cherry

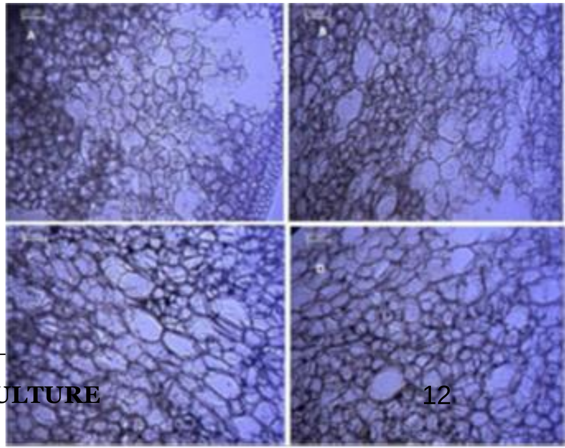
– Cell number stable, under genetic control?

– Cell expansion affected by environment/management

– Cell division predominantly in Stage I of fruit growth

– Between bloom and pit-hardening (Zhang and Whiting 2013)

– Bing; peak at 8 – 10 days after full bloom



Difficult to quantify, size an early indicator?

Project
Early fruit formation and mature fruit quality

	1	2	3	4	5	6	7	8
Site	1	2	3	2	4	2	3	1
Year	13	13	14	14	15	15	14	14
Var	L	L	L	L	L	L	SG	Sw
RF	5	8	66	24	100+	100+	51	21

Was growth promoted?
Did Cytolin increase fruit size?
Was style retention and cuticle integrity impacted?
Did this alter the level of scar development?
Did this alter the level of scars progressing to cracks?
Was fruit quality affected?

Project
Early fruit formation

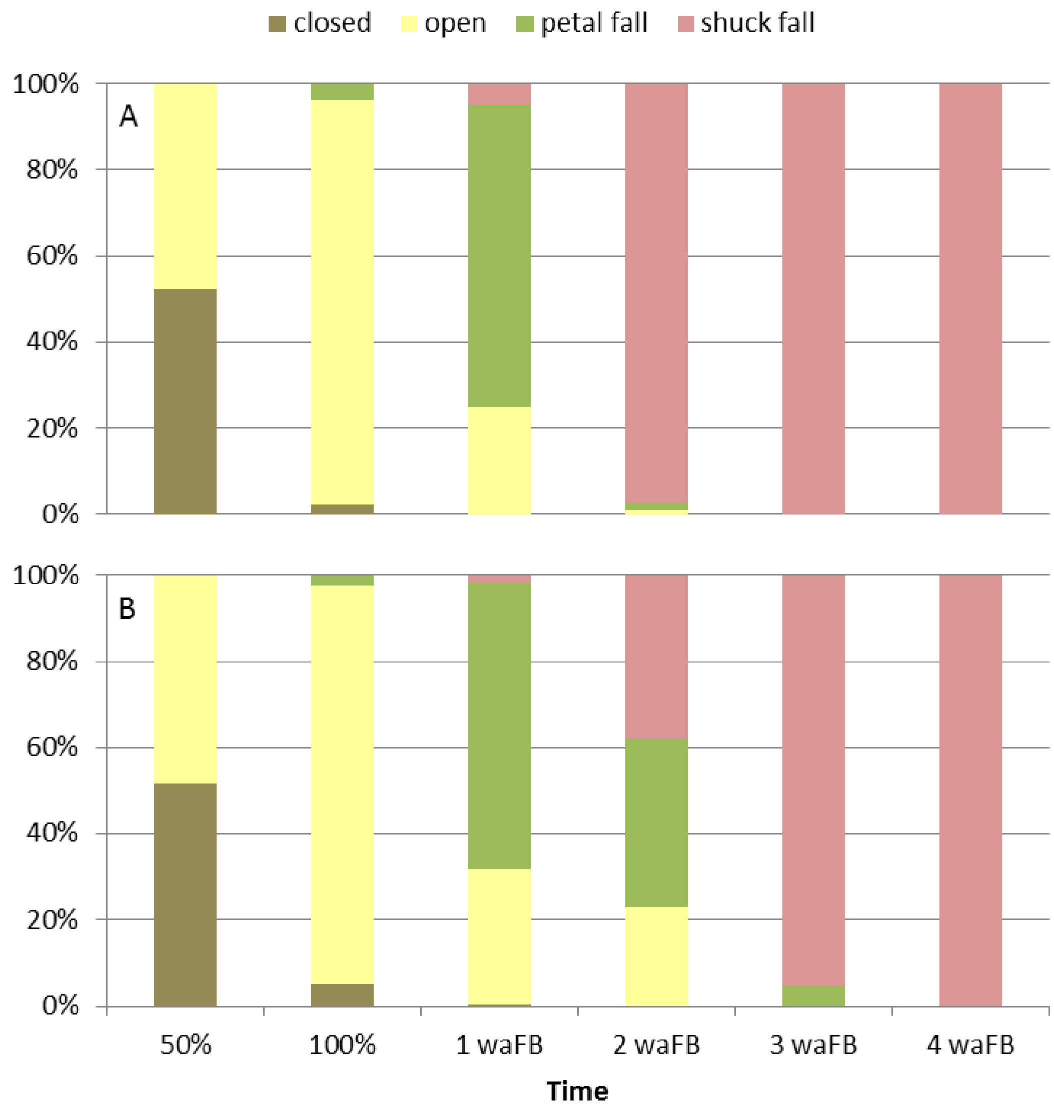
Floral development and early fruit growth

Significant ($P < 0.01$) difference in number of flowers still open, and with petals 2 waFB, time taken to reach 100% shuck fall was extended

Small increase in length and width of fruit 3 waFB;

Length; 8.14 mm (±0.16)
7.67mm (±0.21)

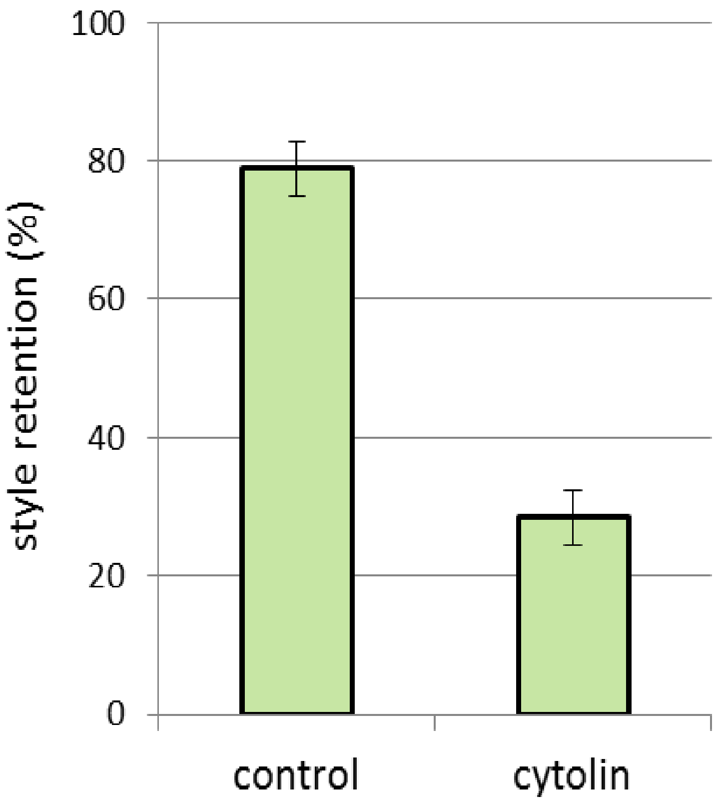
Width 5.68 mm (±0.14)
5.53 mm (±0.19)

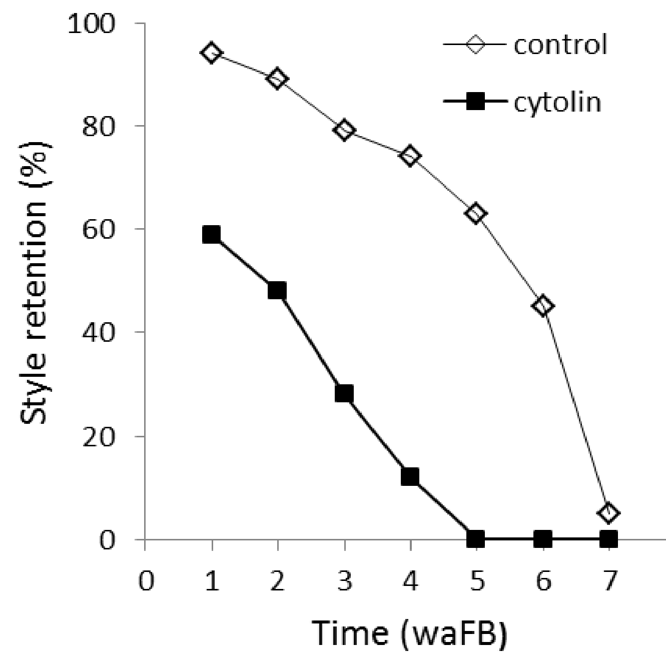


A – cytolin, B - control

Project
Early fruit formation

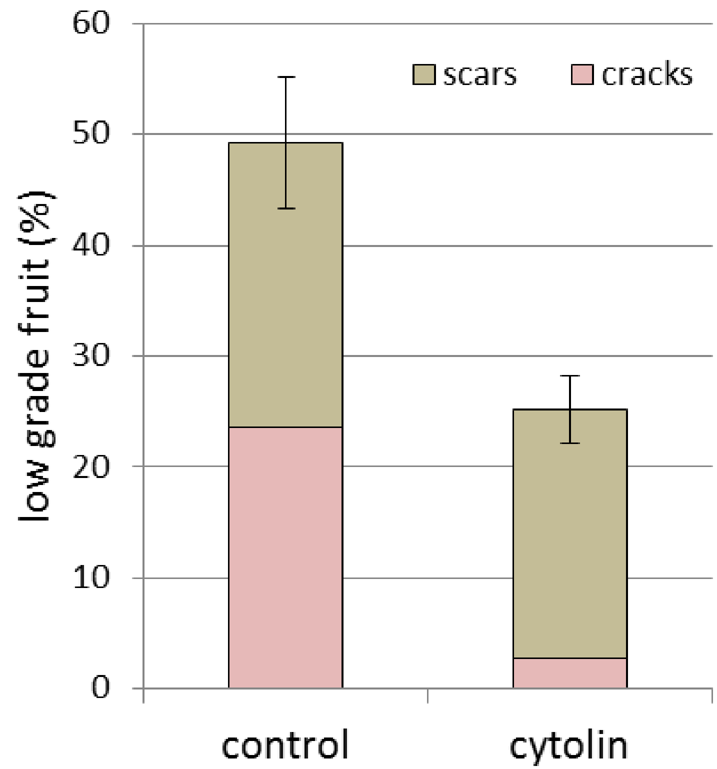
Floral development and early fruit growth – style retention





Project
Mature fruit quality

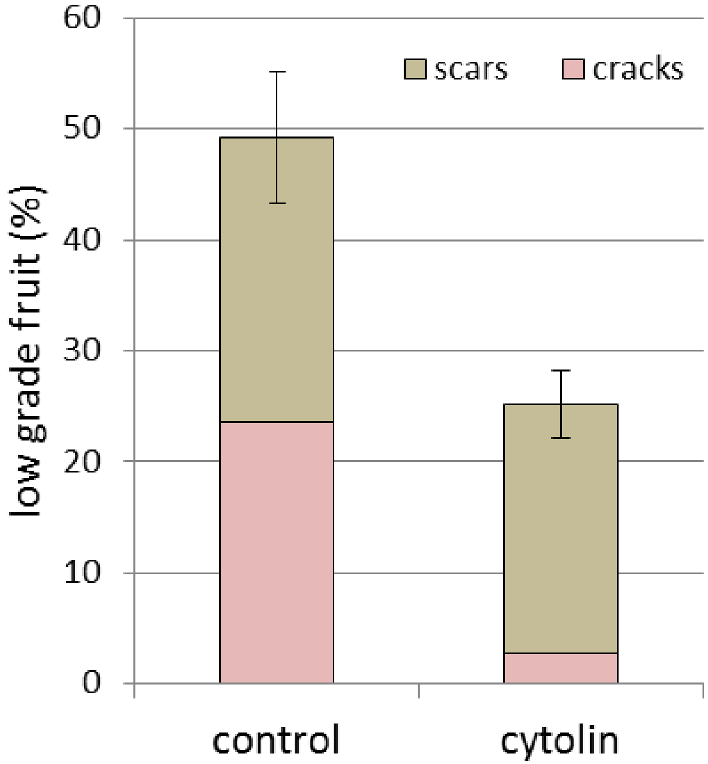
Scarring and cracking

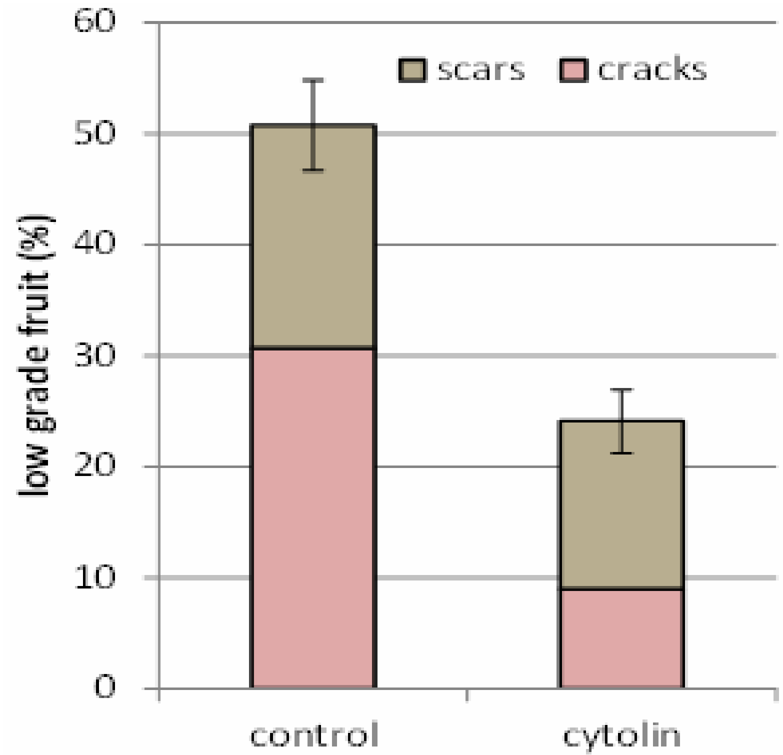


Significant reduction in scarring in fruit from trees with cytolin application

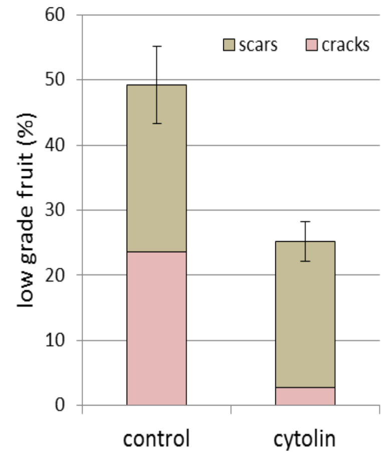
A greater proportion of scarred fruit developed apical-end cracks in control trees

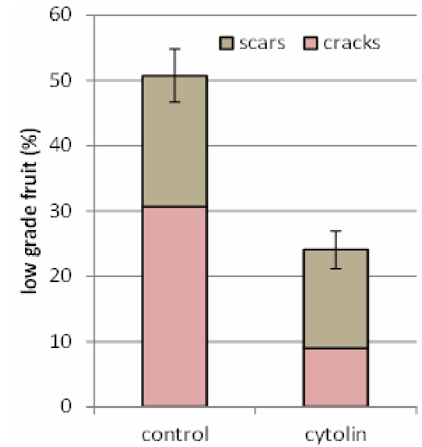
Project
Mature fruit quality

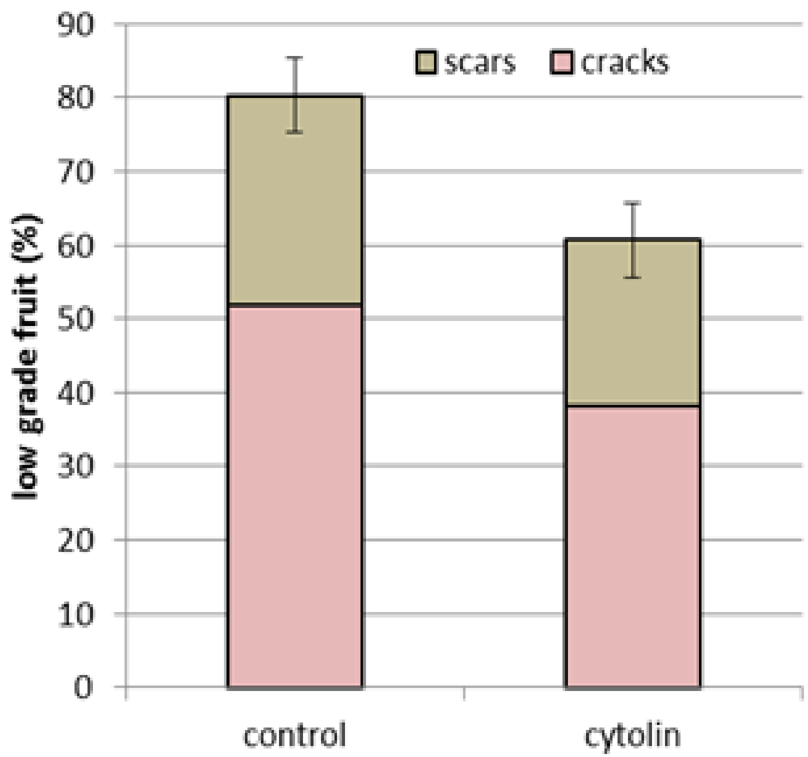




Project
Mature fruit quality









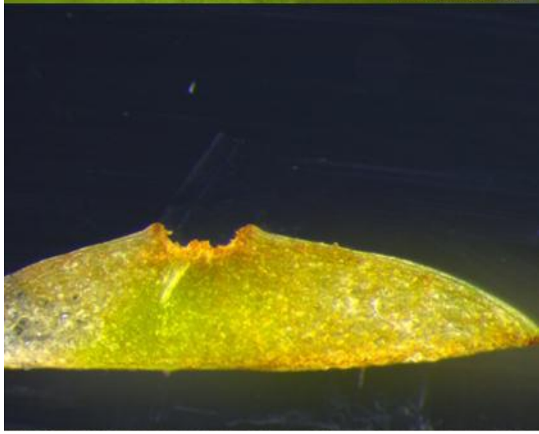

Project
Mature fruit quality

Fruit scars and cuticle

– No difference in scar size;
Length, width, height

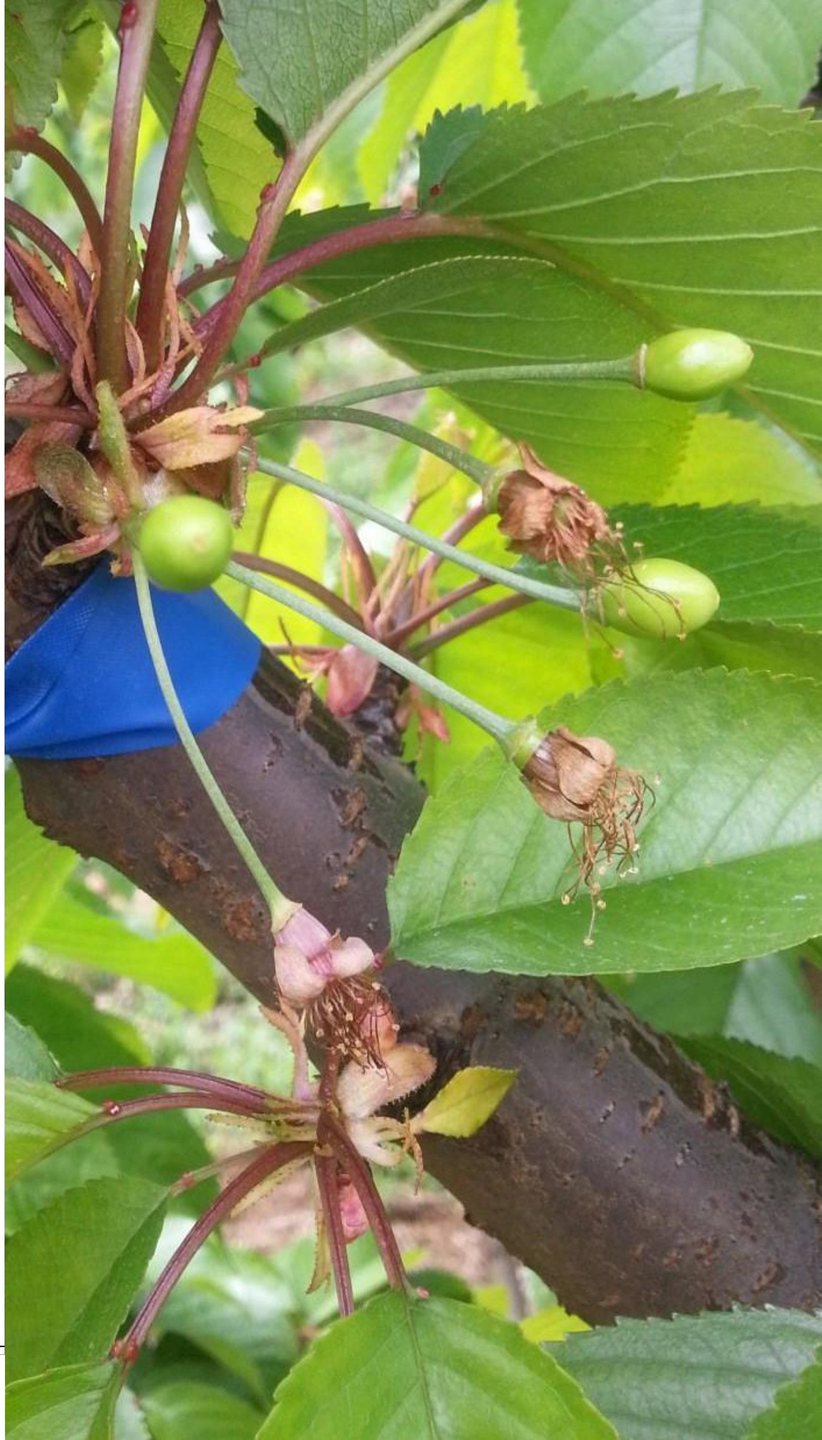
– Cuticle was thicker with Cytolin application
3.35 µm compared to 4.97 µm

Measured at stage II*
By harvest – cuticle stretched;
to 1 µm (Bargel et al. 2004)




Stage I

- 3-5 weeks
- Rapid cell division
- Development of cuticle and waxes
- Low rate of cuticular membrane conductance
- Green, photosynthesis



Stage II

- 1-2 weeks
- Mesocarp cells show little change
- Slowing of cell division
- Low rate of cuticular membrane conductance
- Green, photosynthesis
- Pit – hardening, lignification

Early Stage III

- 4-5 weeks
- Cell expansion
- Anthocyanin expression/colour development
- Increased rate of cuticular membrane conductance
- No new cuticle

Late Stage III

- Rapid cell expansion
- Fruit tissue softening/ripening
- Influx of sugars and water drive growth
- Increased phloem flow compared to xylem flow to fruit
- Cuticular membrane conductance slows

Project
Mature fruit quality

Fruit size

		Weight [mean ± SE (g)]	Height [mean ± SE (mm)]	Width [mean ± SE (mm)]
Site 1	Control	13.89 ± 0.39	26.60 ± 0.56	29.31 ± 0.47
	Cytolin	14.40 ± 0.58	27.14 ± 0.26	30.42 ± 0.37
Site 2	Control	15.77 ± 0.63	27.30 ± 0.29	30.85 ± 0.27
	Cytolin	16.62 ± 0.57	28.13 ± 0.11	31.60 ± 0.09

Project
Mature fruit quality

Fruit size

No impact on any other quality parameters

Trials 5 and 6 not harvested

Trial		Width [mean ± SE (mm)]
1	Control	**29.14 ± 0.47**
	Cytolin	**30.58 ± 0.37**
2	Control	**30.85 ± 0.27**
	Cytolin	**31.60 ± 0.09**
3	Control	**26.04 ± 0.30**
	Cytolin	**27.77 ± 0.12**
4	Control	26.17 ± 0.21
	Cytolin	26.67 ± 0.14
5	Control	25.22 ± 0.20
	Cytolin	24.90 ± 0.20
6	Control	25.63 ± 0.27
	Cytolin	25.20 ± 0.26

Project
Early fruit formation

Fruit set

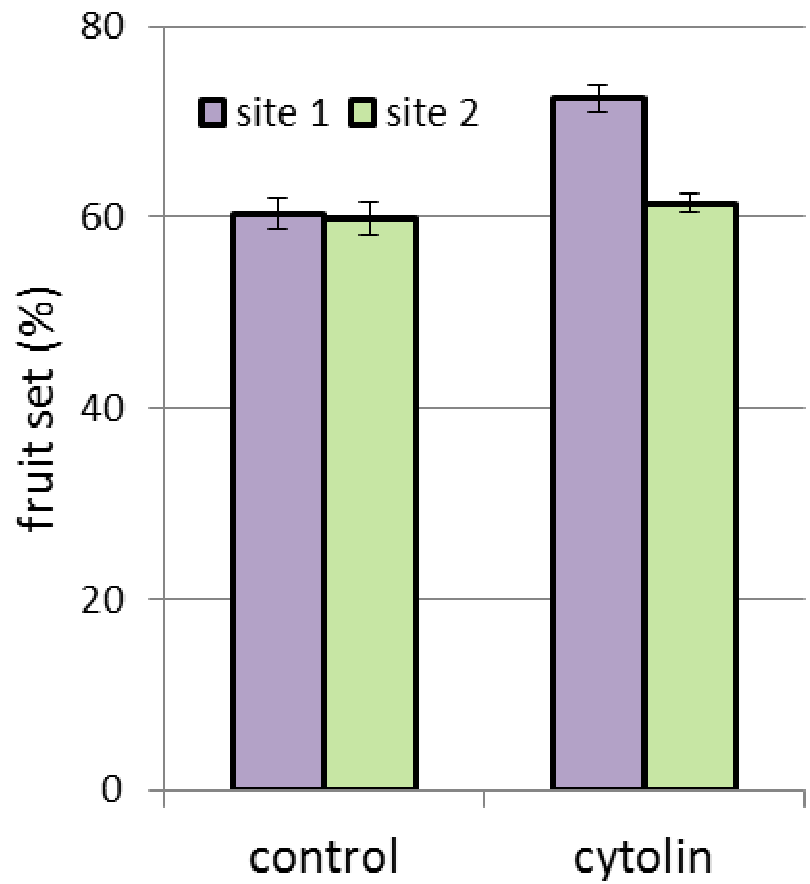
Increased fruit set at site 1

No style retention

Warmer spring

Lapins

Is there potential for increasing fruit set in low-setting varieties?



Project
Early fruit formation and mature fruit quality

Summary

– Aim; to build resilience into fruit by ensuring complete floral closure and preventing apical scar tissue

– Results;
  - Promoted faster floral shedding
  - Reduced style retention
  - Increased cuticle thickness
  - Reduced apical scarring and apical-end cracking
  - No effect on size of scar
  - Increased fruit set in site with warmer spring
  - Fruit size improved in some trials

Project
Early fruit formation and mature fruit quality

2014

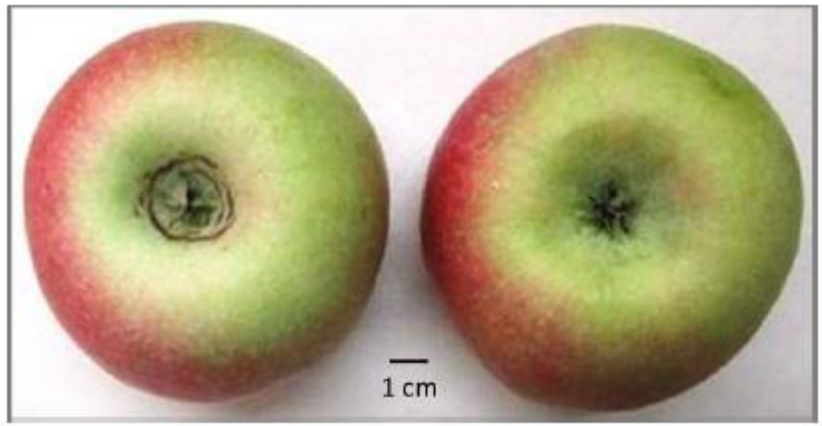


Fig. 1. Calyx-end cracking in 'Pink Lady' (left) compared to a normal fruit (right). Scale bar = 1 cm.

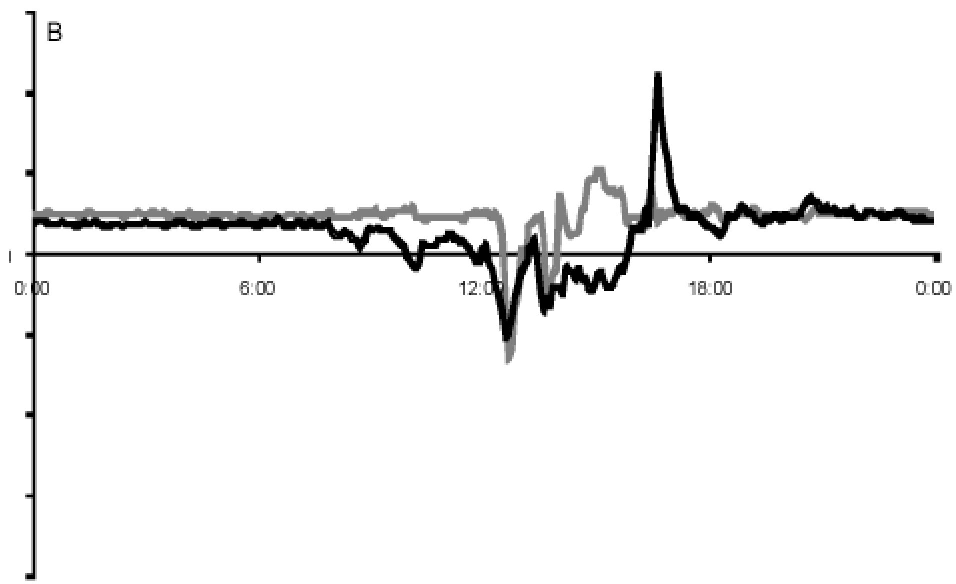
Maintenance of high epidermal cell density and reduced calyx-end cracking in developing 'Pink Lady' apples treated with a combination of cytokinin 6-benzyladenine and gibberellins A_4+A_7

Idit Ginzberg[a,*], Edna Fogelman[a], Lior Rosenthal[a], Raphael A. Stern[b,c]

Project
Early fruit formation and mature fruit quality

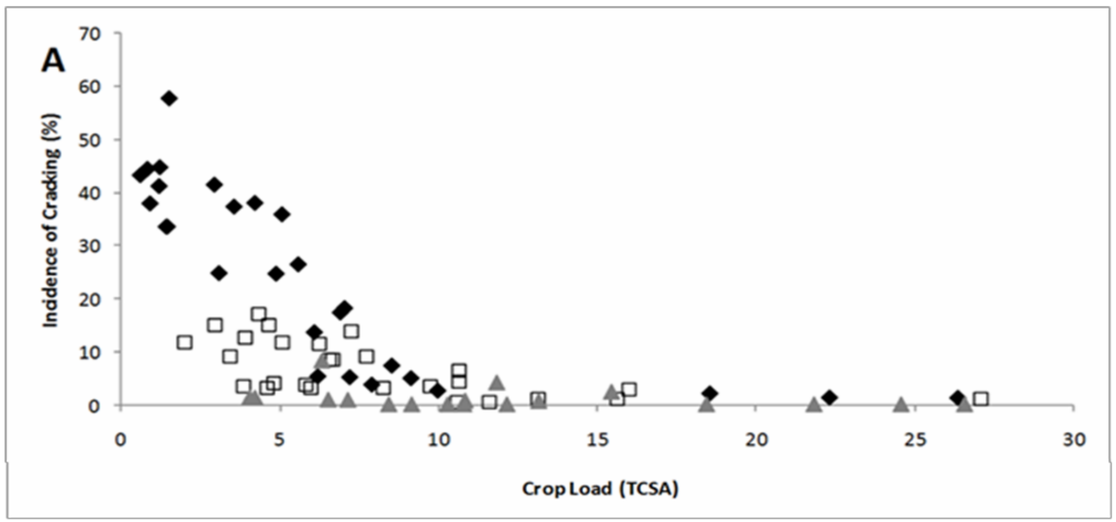
Aim; to limit uptake of excess water following rainfall

- No rainfall, or too much rainfall, occurred at designated trial sites
- Root pruning close to harvest did not occur



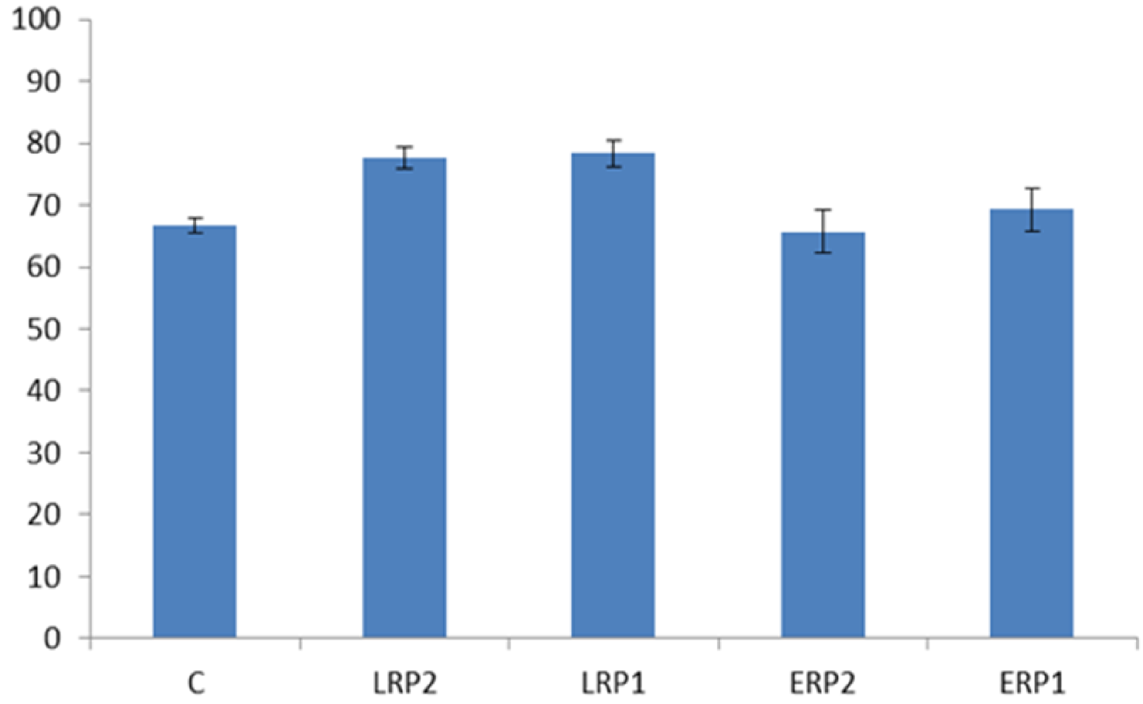
Project
Early fruit formation and mature fruit quality

Aim; to build resilience by increasing crop load



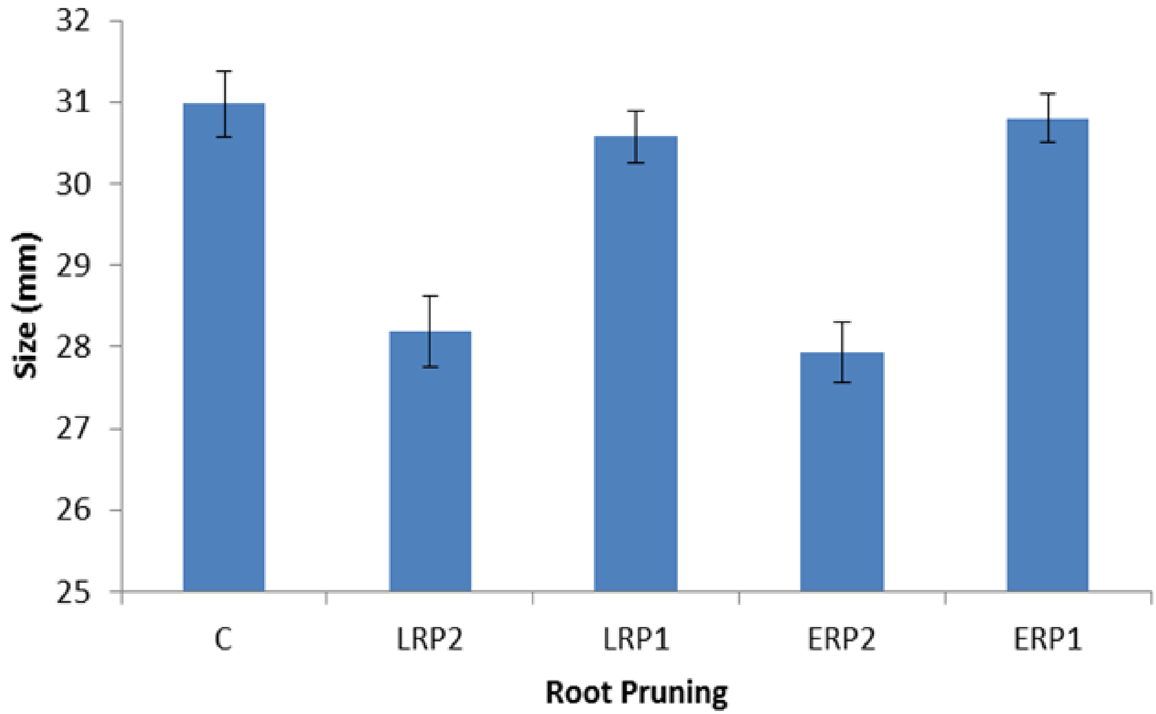
- Root pruning prior to bud burst impacted on fruit quality
- Root pruning on both sides (RP2) reduced fruit size
- Suggests reduced influx (water or carbohydrates) to fruit
- Potential for management??

Project
Early fruit formation and mature fruit quality



Root pruning prior to bud burst increased crop load (1 or 2 sides)
Root pruning earlier did not

Project
Early fruit formation and mature fruit quality



Root pruning prior to bud burst impacted on fruit quality
Root pruning on both sides (RP2) reduced fruit size
Suggests reduced influx (water or carbohydrates) to fruit
Potential for management??

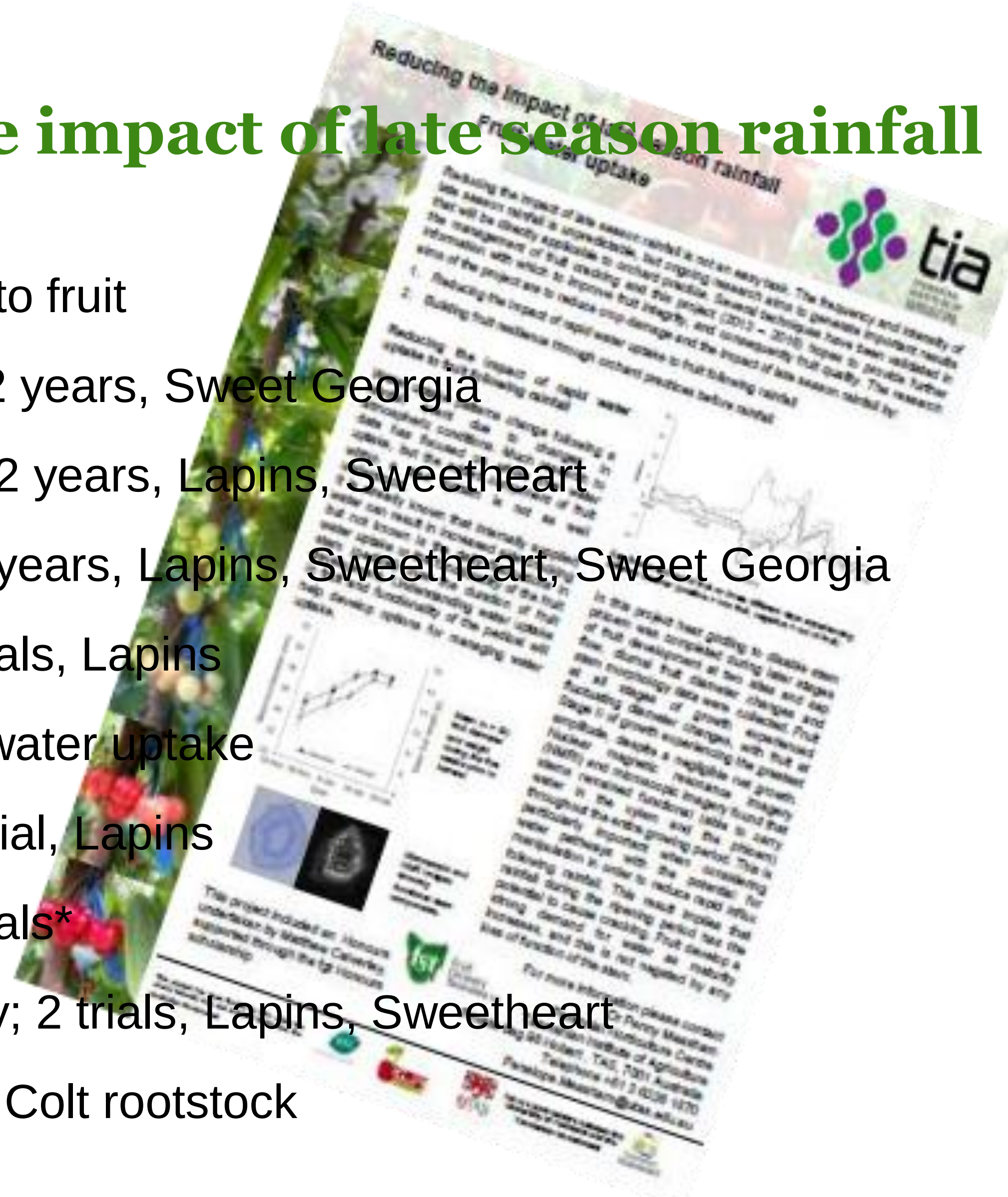
Project
Early fruit formation and mature fruit quality

Root pruning prior to bud burst impacted on fruit quality in the second year

Fruit set increased by 25%
Cracking decreased from 12 to 9%

Fruit size increased from 14.5 to 15.7 g
No impact on sugars, firmness

Project
Reducing the impact of late season rainfall
CY12000



Building resilience into fruit

- Calcium; 5 trials, 2 years, Sweet Georgia
- Irrigation; 3 trials, 2 years, Lapins, Sweetheart
- Cytolin: 8 trials, 3 years, Lapins, Sweetheart, Sweet Georgia
- Root pruning; 2 trials, Lapins

Reducing impact of water uptake

- Ground cover; 1 trial, Lapins
- Root pruning; 0 trials*
- Xylem conductivity; 2 trials, Lapins, Sweetheart
- Soil fungi; 2 trials, Colt rootstock

Project
Early fruit formation and mature fruit quality

Thank you

Acknowledgements

This project has been funded by Horticulture Innovation Australia Ltd using the cherry industry levy, voluntary contributions and matched funds from the Australian Government.
Thank you to Matthew Griggs, Ryan Hankin, Howard Hansen, Shane Hutcheon, Neil Polley and Peter Morrison, and to the Perennial Horticulture Centre students and staff.

"This really is an innovative approach, but I'm afraid we can't consider it. It's never been done before."

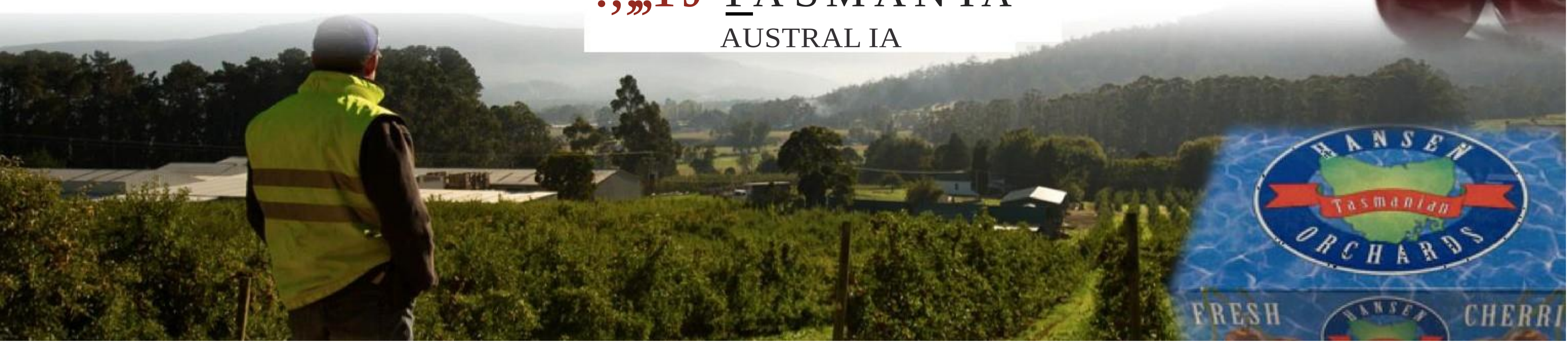
ARC Industrial Transformations Training Centre in Innovative Horticultural Products

the fresh food people
Woolworths

Australian. Gcmrmnent
.Austnlian Research Coundl

UNIVERSITY *of* TASMANIA
AUSTRAL IA

PROUDLY TASMANIAN
HOUSTON'S FARM



Appendix K – Issues raised by the reference group a the end of the NCDP in 2016.

Listed below are cherry industry issues raised by industry representatives during NCDP consultations in 2016. This list was circulated to the NCDP reference group members on 8 /11/2016. Reference group members are still developing the priority ranking for the issues identified by cherry growers in 2016.

Descriptions of issues conveyed during consultations with the NCDP reference group and individual cherry growers.
Growers experienced issues with cultivars, shy bearing and **genotype x environment interactions**. • What are the best new cultivars and genetics? • Can industry benchmarking help identify cultivars, rootstocks, climatic conditions and soil types? • What are the best cultivar rootstock combinations?
Fruit cracking issues • Major concern with shy bearing cultivars (low crop load = high risk of cracking). Shy bearing cultivars are losing support from growers • Fine cracks invisible to the naked eye and incidence of pathogens • Rain out shelters and their use, profitability? Will rain out shelters give us the maximum benefit in profitability, fruit quality and marketability? Can they all be controlled with rainout shelters? What is the economics of rainout shelters? • Rainfall, irrigation and fruit cracking, what are the critical factors? How do the plants and fruit respond • What are the biological mechanisms involved in fruit cracking?
Fruit Shedding and shy bearing • Flowering, flower shedding, and fruit set issues are major concerns. • Is shedding due to genotype x environment interaction or is it due to management practices? • What are the main factors involved in fruit shedding? • How can we control fruit shedding and shy bearing? • Is it the carbohydrate status within the tree or do management practices enhance fruit shedding? • Is a pollination problem? • S alleles of the cultivars presently grown? Are they all known for all cultivars?
Pollination • Pollination issues and how to detect and eliminate defective flowers? • How to set flowers on trees that will produce only premium quality fruit? • Are flowers damaged during winter, due to temperature, or the effects of water stress (drought)? • What are the flow on effects of temperature and drought on flower size and berry growth? • Pollination viability, pollen tube growth, style secretions, fertilisation of the zygote. Are these controlled by climatic conditions only or do carbohydrates and status in the plant play a role? • What vectors are involved in pollination?
Stem retention - major issue. • Represented a major cost for Victorian growers this past season. • If products are available, are their permits for use in cherries? • What are the factors contributing to post-harvest stem loss? Growers indicated the possible causes of post-harvest stem retention occurs in the pre-harvest phase. Factors such as hot weather and temperature variations or plant carbohydrate status, plant hormones (Gibberellins, Cytokines, ethylene, ABA, IAA, NAA, IBA etc). • Genetic makeup of the cultivar? • Growers also realise some cultivars do not have a stem retention problem.

- Many growers felt the prolonged dry, issues with water stress, high temperatures, climate variability, and crop loading may have contributed to post-harvest stem retention issues.

Enhancing productivity?

- Growers feel that GA, its application method, timing, rates and effects were not scientifically trialled and further work is needed to improve its success.
- Enhancing productivity through the use of plant bio regulators?

Crop loading? Crop loading is a major problem for growers.

- Obtaining a crop load level to produce high quality fruit, and reduce the variability in fruit quality are major concerns.
- Eliminate overcropping and refine management practices to eradicate the occurrence of inconsistent fruit quality due to heavy crop loads.
- Overcropping: growers indicated that pruning plays a part, but it is not the only major component to eliminate overcropping. Tree structure, bud density etc., are factors prior to pruning that may contribute to overcropping.
- There is a need to identify and sequence all management practices to eliminate overcropping and produce premium quality fruit.
- How will growers put it all the factors together to produce this premium quality fruit?

Orchard Design?

- Future orchards designs, mechanical pruning and harvesting.
- How to upgrade orchards to new production systems? What is the best orchard system, fruiting walls? Pedestrian orchards of free standing trees
- What is the best cultivar rootstock combinations for the different training systems?

Economics of cherry production?

- What is the best production system (orchard design, tree architecture) cultivars, rootstocks, replanting and upgrading of an orchards
- What does it cost to raise a 3 year old tree?
- What are the variable, fixed and capital costs?
- What is the cost of implementing orchard protection systems for rainfall, hail, birds etc.?
- Growers are focused on obtaining a profit from their orchards. – Potential future project.
- Economics of cherry production, budgeting spreadsheet incorporating variable costs, fixed costs, producing information on the return of investment, cost of production per box, per tree, per hectare, acuminate cash discount flow graph, break-even point and sensitivity analysis etc. Bob Nissen has developed a spreadsheet that incorporates all these elements.

Qld Fruit Fly (QFF) is a major issue and has a substantial impact on market access for NSW.

- What are the most up to date methods of control?
- How do growers implement an approach to eliminate QFF?
- Growers feel that QFF is not a significant pest during fruit maturation and harvesting, (before February). However, QFF numbers build up in orchards after harvest (in February).

Market readiness?

- Do growers understand what market readiness is?
- What is market readiness for exporting or for the domestic markets?
- How to reduce poor quality fruit entering the market and causing damage to the good will established with, packers, wholesalers, agents, marketers, retailers?
- Over supply of low quality fruit reducing prices and turning off customers and consumers.
- Air freight vs sea freight disinfestation treatments methyl bromide, irradiation for export.
- Costs to growers and industry?

Revamp of Australian Cherry Production Guide (2011).

- Established growers many not use manual. Little knowledge about manual by growers.

• What references and information is available to new growers. • Manual need to be revamped to make it useful to all Cherry Growers. • Ring binder Style Manual where sections can be easily upgraded • Web site with the latest information and small YouTube clips. • GAP/Best Practice Manual. • This to be discussed further with cherry growers and funding considerations.
National Cherry Development Program. • Phase 2 of the national cherry development program? • What will it entail? • Future Cherry Orchards Programs based on the Apple Industry Future Orchards Program? • Growers participate and self-directed regional groups? • What is the structure? • How will it be funded?
Development of agronomic packages? • Pruning and training systems, irrigation, fertilising, flowering, pollination and fruit set and retention, fruit development and harvesting?
Harvest Indices? • What are the harvest indices for each cultivar to access markets (domestic and export)? • When should we harvest, on the advice of the agent? • What are the critical parameters to assess when to harvest? • When are the critical fruit quality parameters to gain market access? • Where can I find the requirements? • What are the quality specifications for the export market?

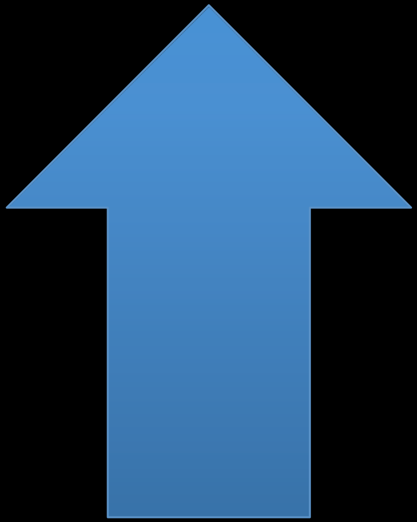
Appendix L – NCDP Presentations by Ass Prof Matthew Whiting and Mr Bob Nissen

Tree Fruit Research at the Intersection of Biology and Technology

Matthew Whiting Washington State University

Necesitamos Ayuda

Key Production Trends:



Cherry orchard of the future

- Profitability
- Sustainability

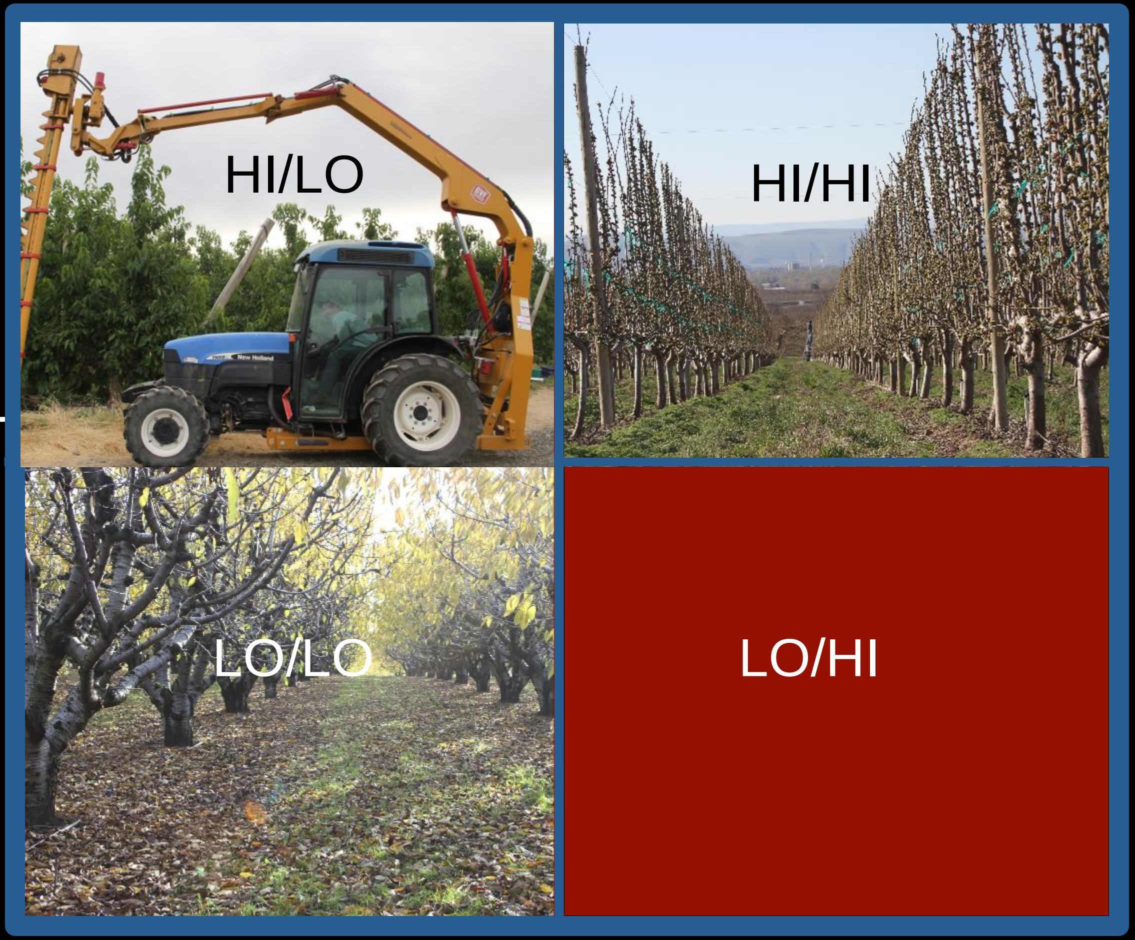
- Right genetics
- Right location
- Right management

Efficient, consistent, balancedproduction

Output *vs*. Input:

Production systems

OUTPUT



INPUT

Is this the orchard of the future?

Is this the orchard of the future?

·is this the orchard of the future?

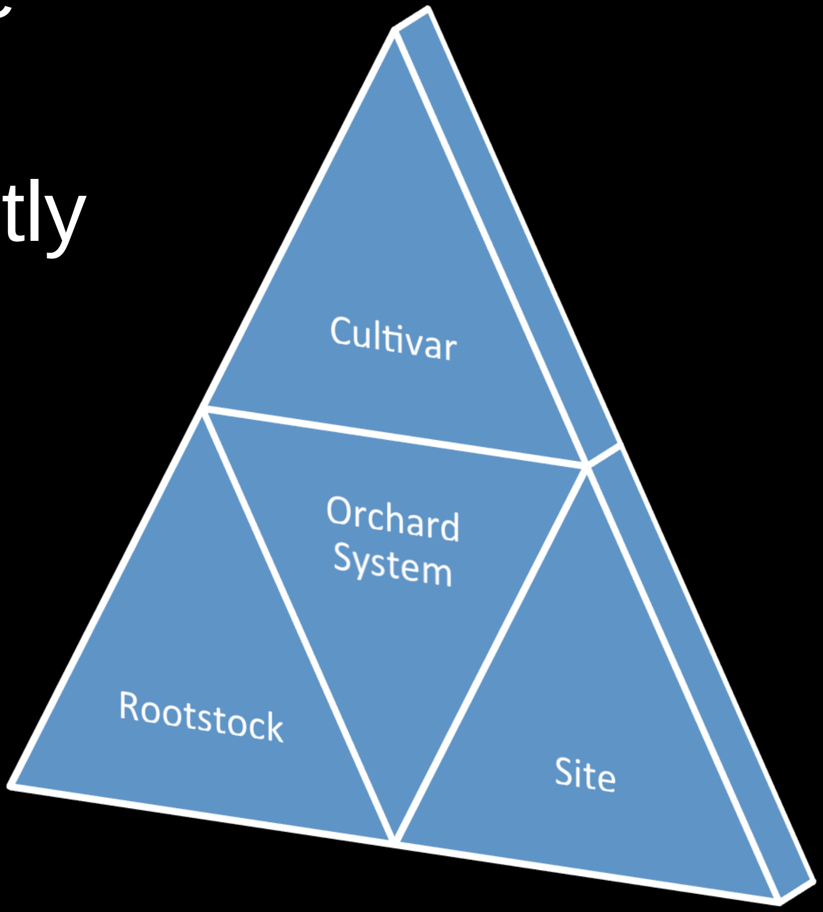
Is this the orchard of the future?

Is this the orchard of the future?

Keys to future orchards:

- Profitable + sustainable
- Simple pruning/training
- Precocious + consistently productive

- Ability to utilize automation/ mechanization



Is this the orchard of the future?

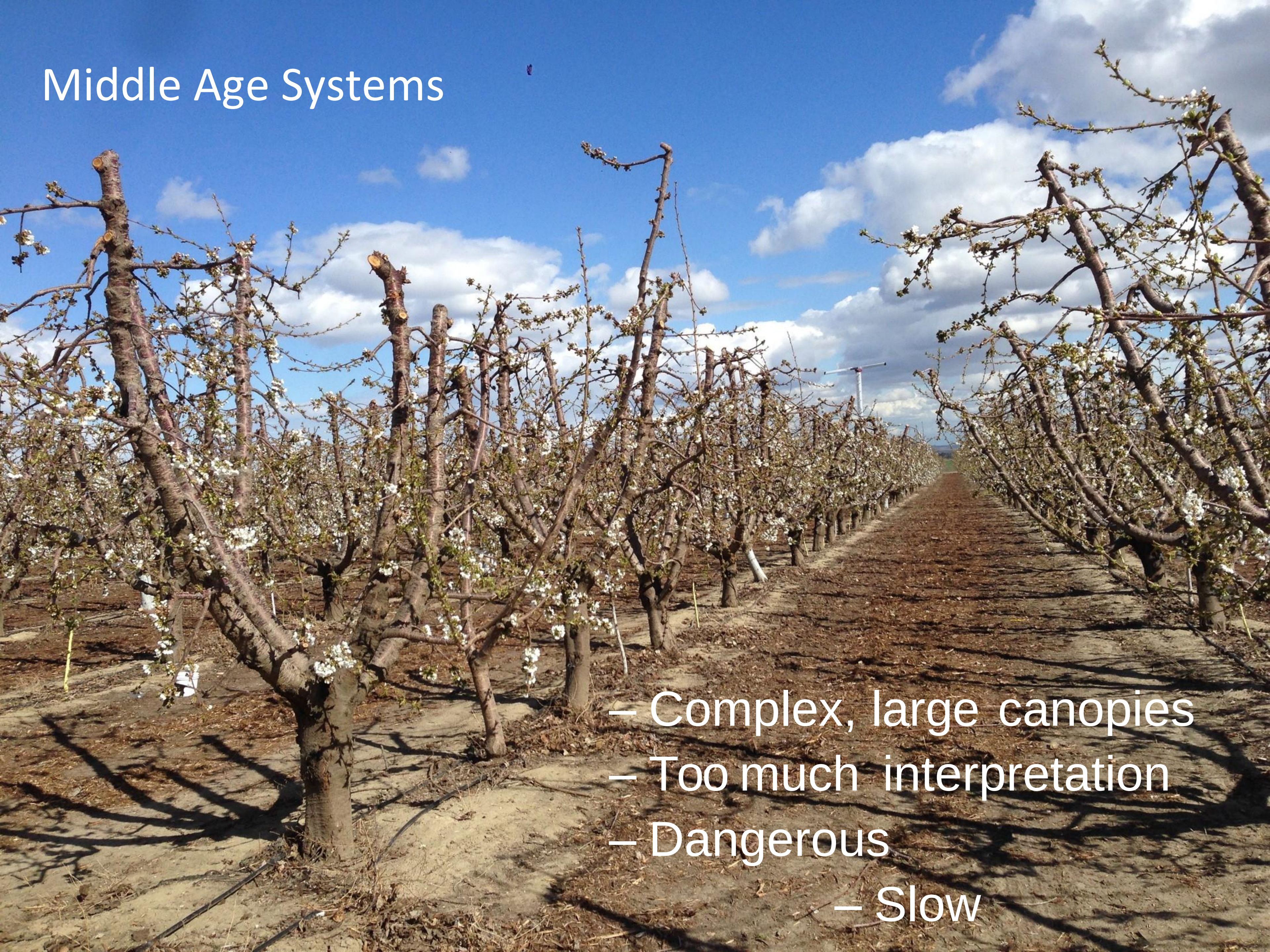

2
1


What is successful in other crops?
Jazz/M9 – 100+ tons/ha

Old Systems

- Complex, large canopies
- Too much interpretation
- Dangerous
- Slow

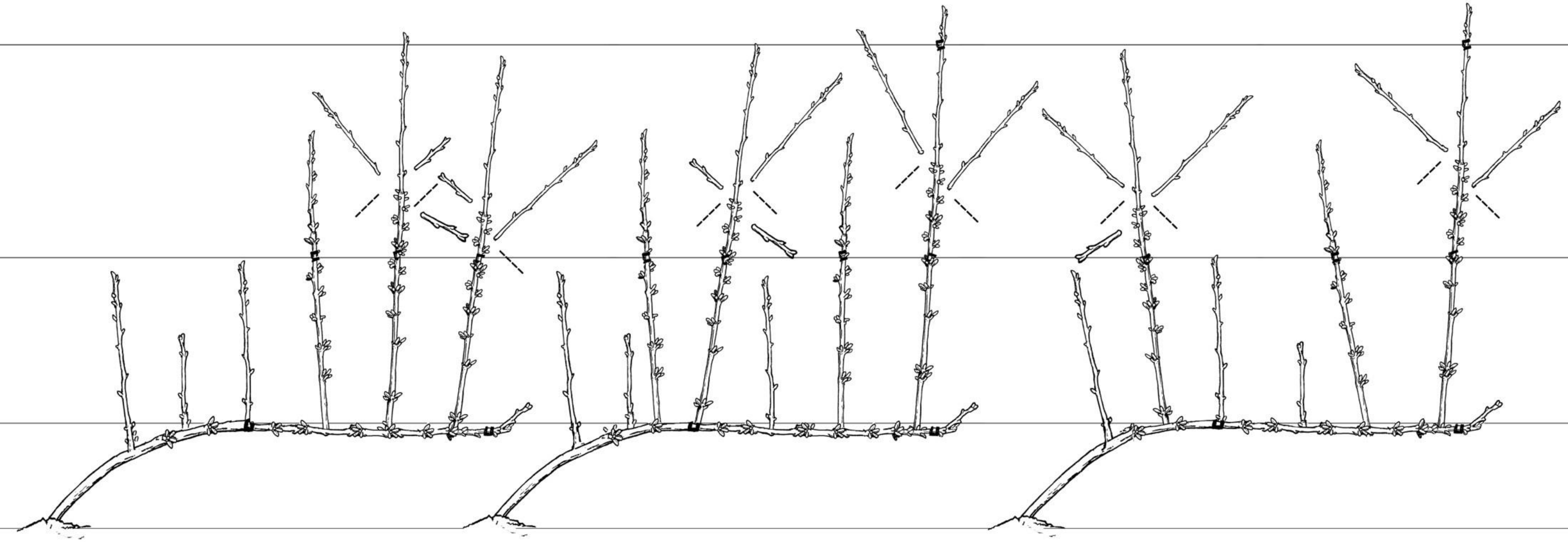
Middle Age Systems



– Complex, large canopies
– Too much interpretation
– Dangerous
– Slow

- Compact, fruiting wall
- Repeated processes
- Efficient
- Suitable for mechanization/automation

Simplified Pruning of the UFO System:



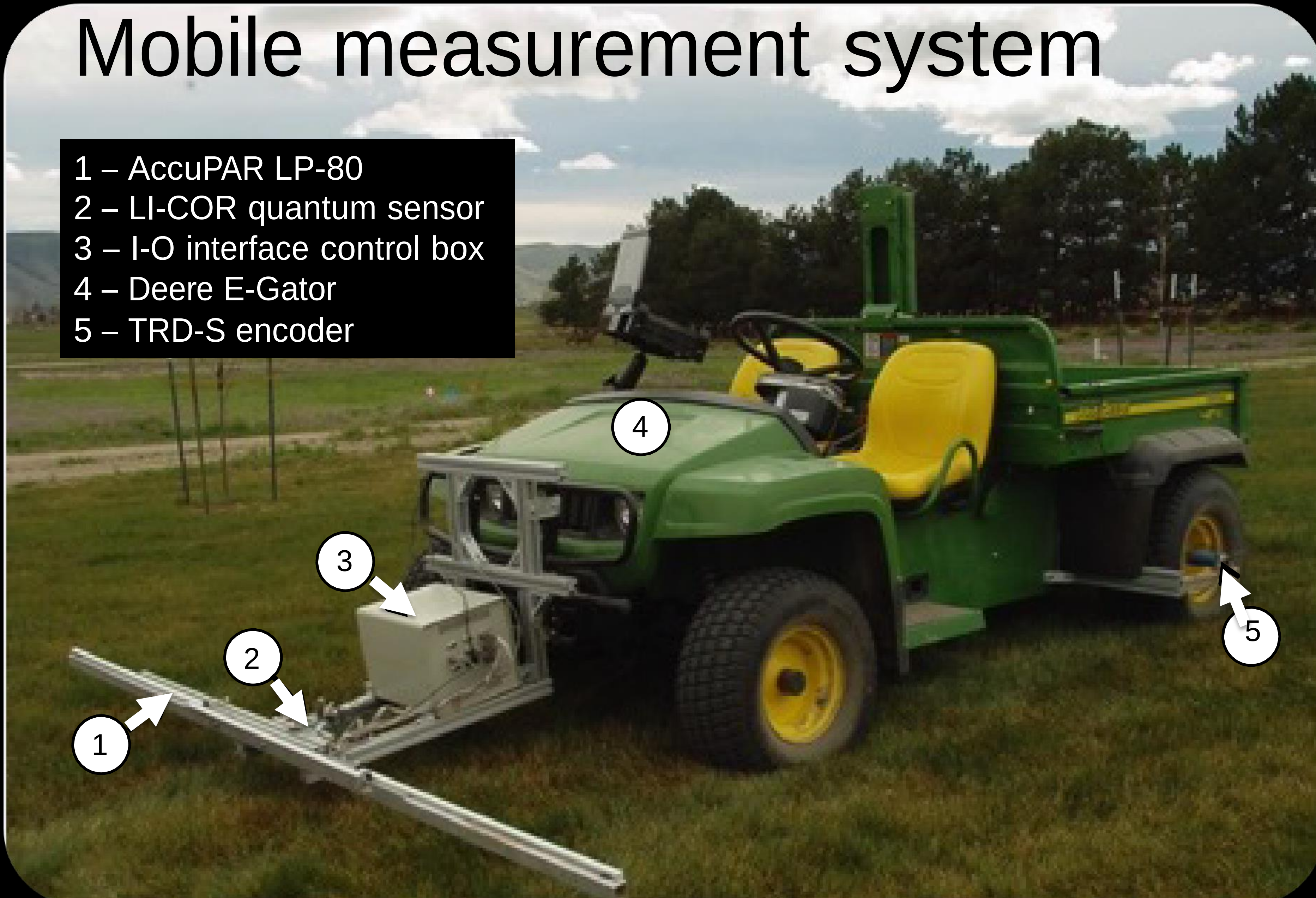
Pruning rules:

1. Remove all lateral wood (leave short stubs)
2. Renew vigorous uprights (leave renewal sites)

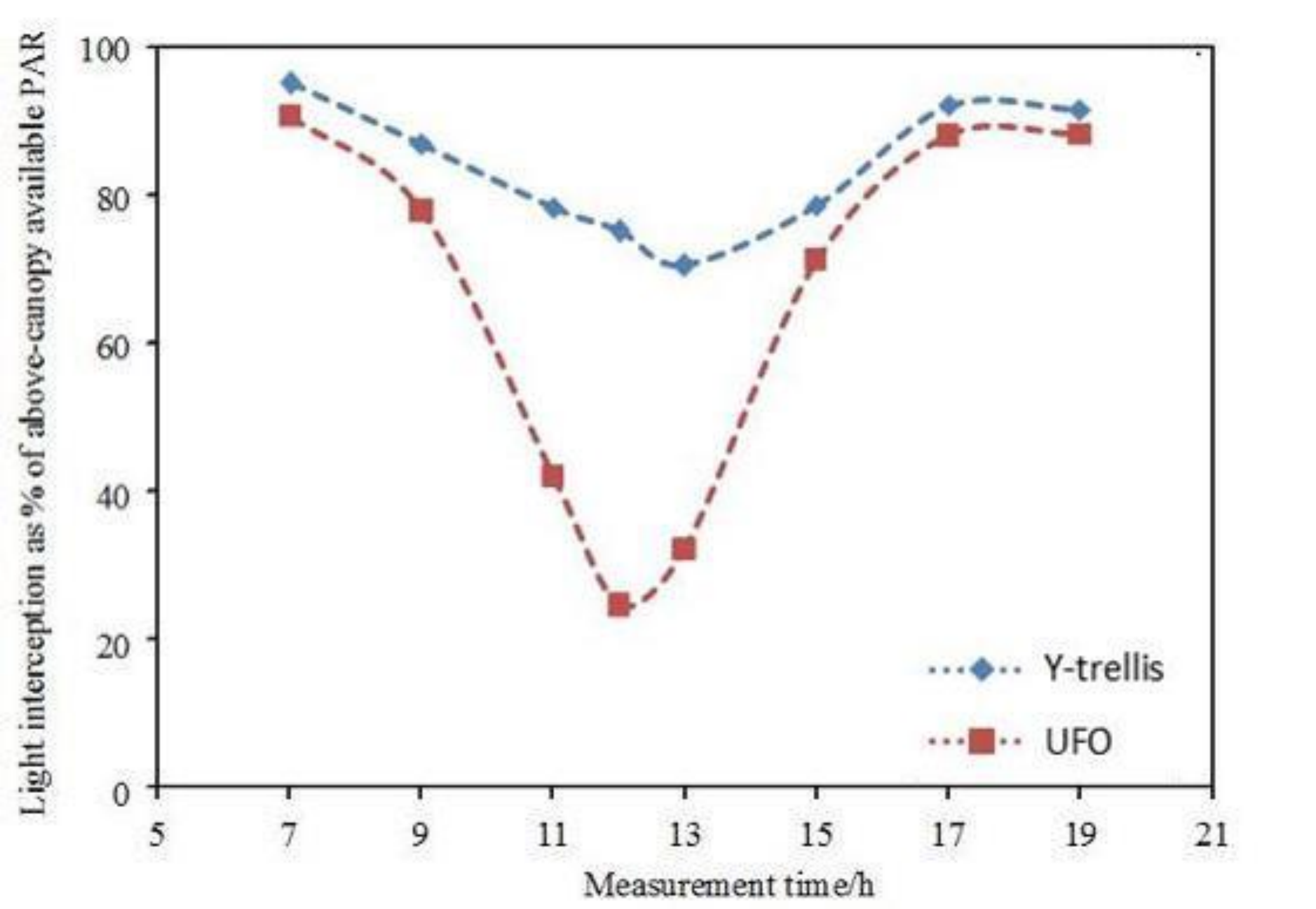
PAR interception of vertical and angled fruiting walls

Vertical UFO

Y-trellised UFO


Mobile measurement system
1 – AccuPAR LP-80
2 – LI-COR quantum sensor
3 – I-O interface control box
4 – Deere E-Gator
5 – TRD-S encoder
1
2
3
4
5

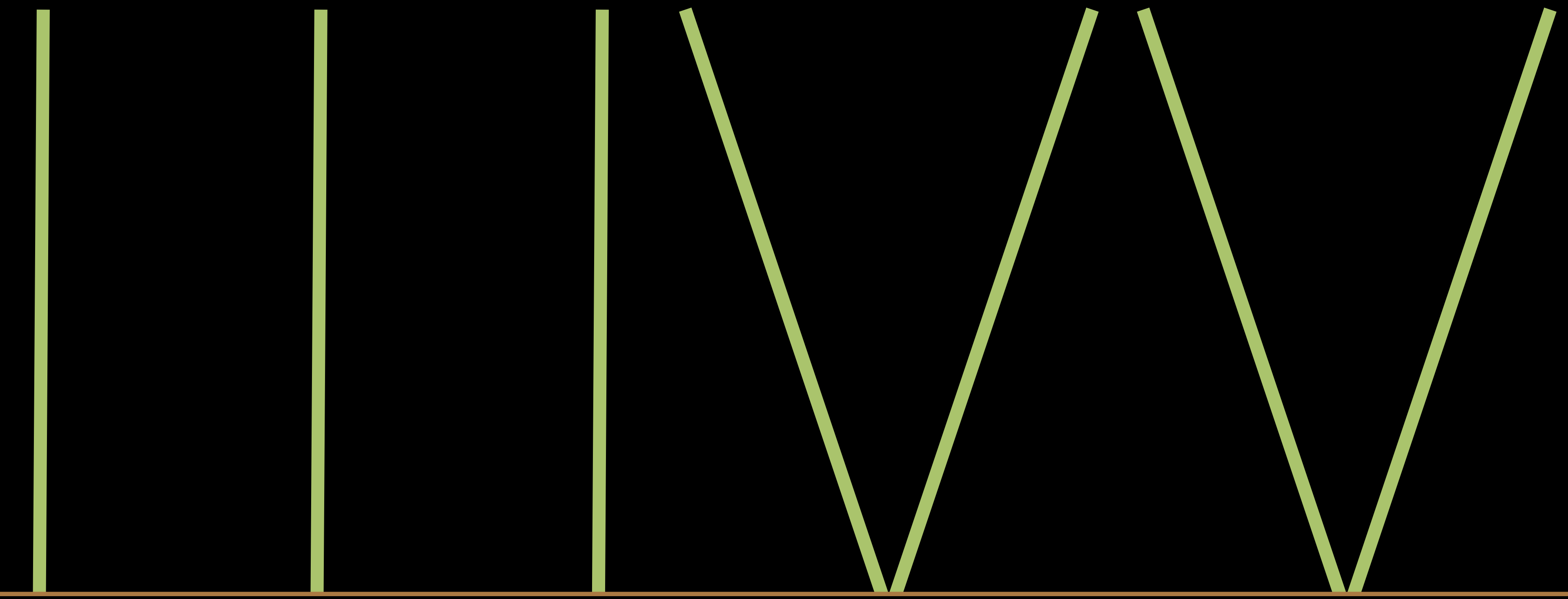
PAR interception of vertical and angled fruiting walls



- Diurnal trend was nearly symmetric around solar noon
- *Yield potential* on angled canopies is greater than planar canopies
    - 5 year-old ‘Santina’/Gisela12 – 35 tons/ha (Y-trellis UFO)
    - 4 year-old 27 tons/ha

Vertical system

Angled system



10 feet 10 feet 12 feet 12 feet

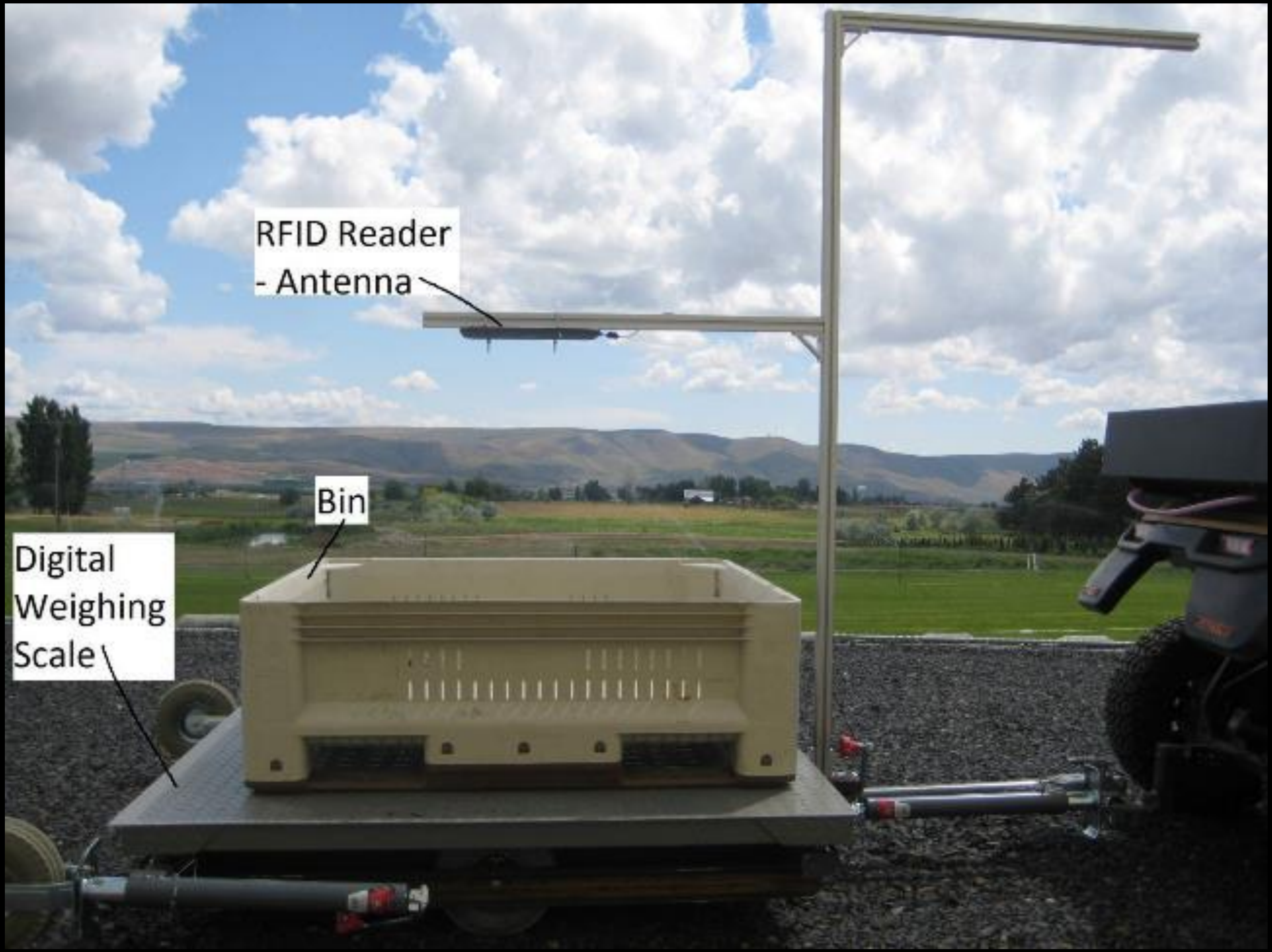
1 ‘wall’ per row

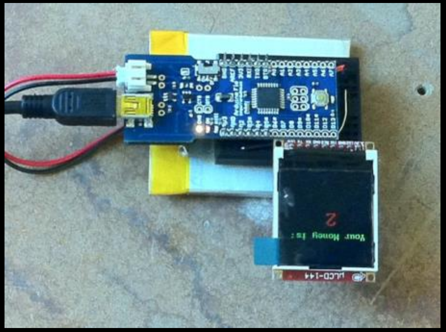
2 ‘walls’ per row

What difference does training system make?


Labor Monitoring System, LMS

Research tool 2011





Harvest efficiency

Preliminary tests in sweet cherries and apples show a clear role of training system in harvest efficiency/costs.

Cul$var		Training System	Mean Harvest Rate (kg/min)
Sweet Cherries	Bing/‘Mazzard’	Tradi,onal open center	***0.47 ± 0.12***
	Chelan/‘Mazzard’	steep leader (4-5 upright leaders)	***0.53 ± 0.13*** *(+13%)*
	Tieton/‘Gi5’	Central leader	***0.64 ± 0.19*** *(+36%)*
	Sweetheart/‘Mazzard’	KGB	***0.72 ± 0.17*** *(+53%)*
	Cowiche	UFO	***0.81 ± 0.18*** *(+72%)*
Apple	Fuji (Apple)	moderate density (7 x 13) central leader	***3.58***
	Braeburn (Apple)	high density tall spindle	***5.61 (+60%)***

Mechanical harvest

- Harvest costs are >50% of all
- Labor cost increasing
- Labor availability decreasing

Mechanical harvest

- Taking short- and long-term look using total systems approach
  - Mechanical assist (shake-and-catch)
  - Fully mechanical harvest

Goal: Improve labor efficiency &safety with mechanical or mech-assist technologies

- 3-4 fold improvement in harvest efficiency with shake-and-catch system
- Worked with 10 growers in 2013/2014 to test/demonstrate the system
- Sold stem-free and stem-on cherries (same price, package, orchard)

Efficient harvest technologies

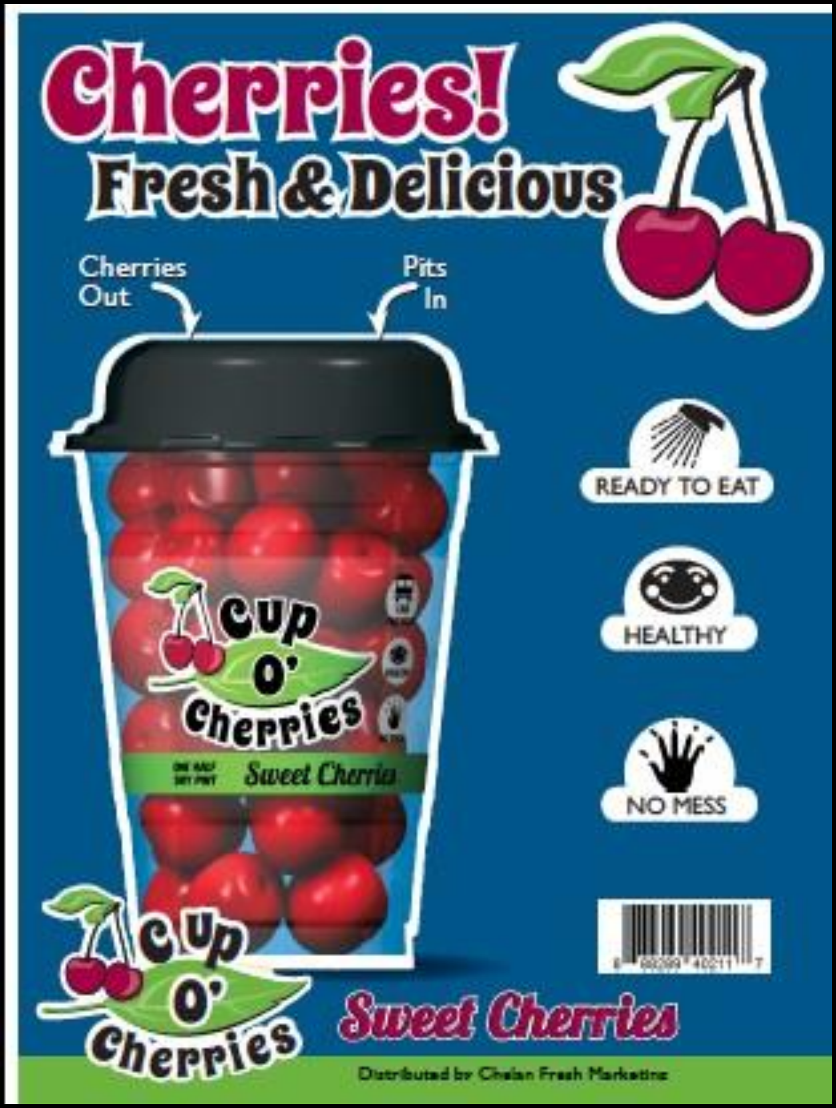
Shake-and-catch harvest testing

Chelan – high PFRF

Skeena – low PFRF


In domestic and export markets, stem-free cherries are accepted/preferred

New packaging + marketing by Chelan Fresh



Utilizing platforms:

- Limb tying
- Thinning
- Pruning
- Harvest

- Work at night

Mechanical pruning

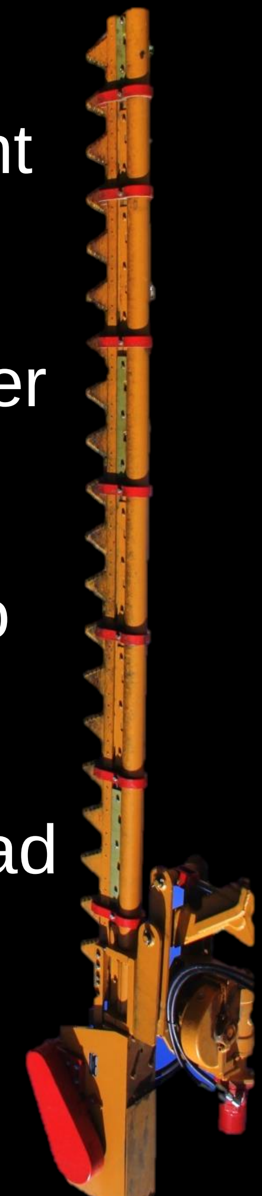
- Simplified planar systems – simplify pruning
- Investigated potential for mechanical pruning in UFO since 2010

Objective

Determine best management practices for pruning sweet cherry and apple mechanically, by understanding equipment and orchard requirements.

Mechanical pruning

- Gillison’s GVF Center Mount Topper and Hedger
- Side shift ca. 1 .2 m on either side of the tractor
- Height adjustment of 1 m to 6.5 m
- 360° rotation of cutting head
- $24,000 USD



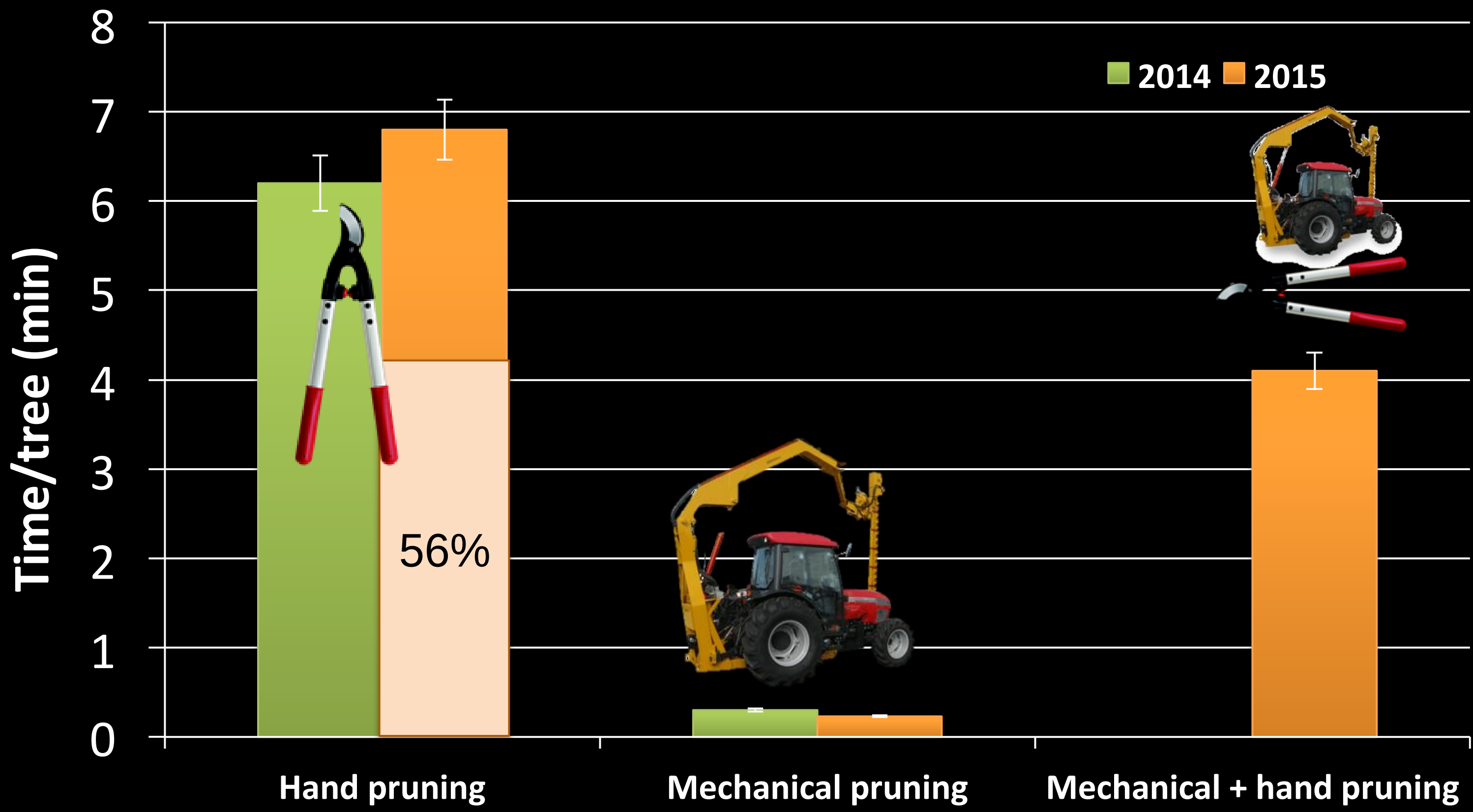
YEAR 1

1. Hand pruning
2. Mechanical pruning (1)
3. Mechanical pruning (2)

YEAR 2

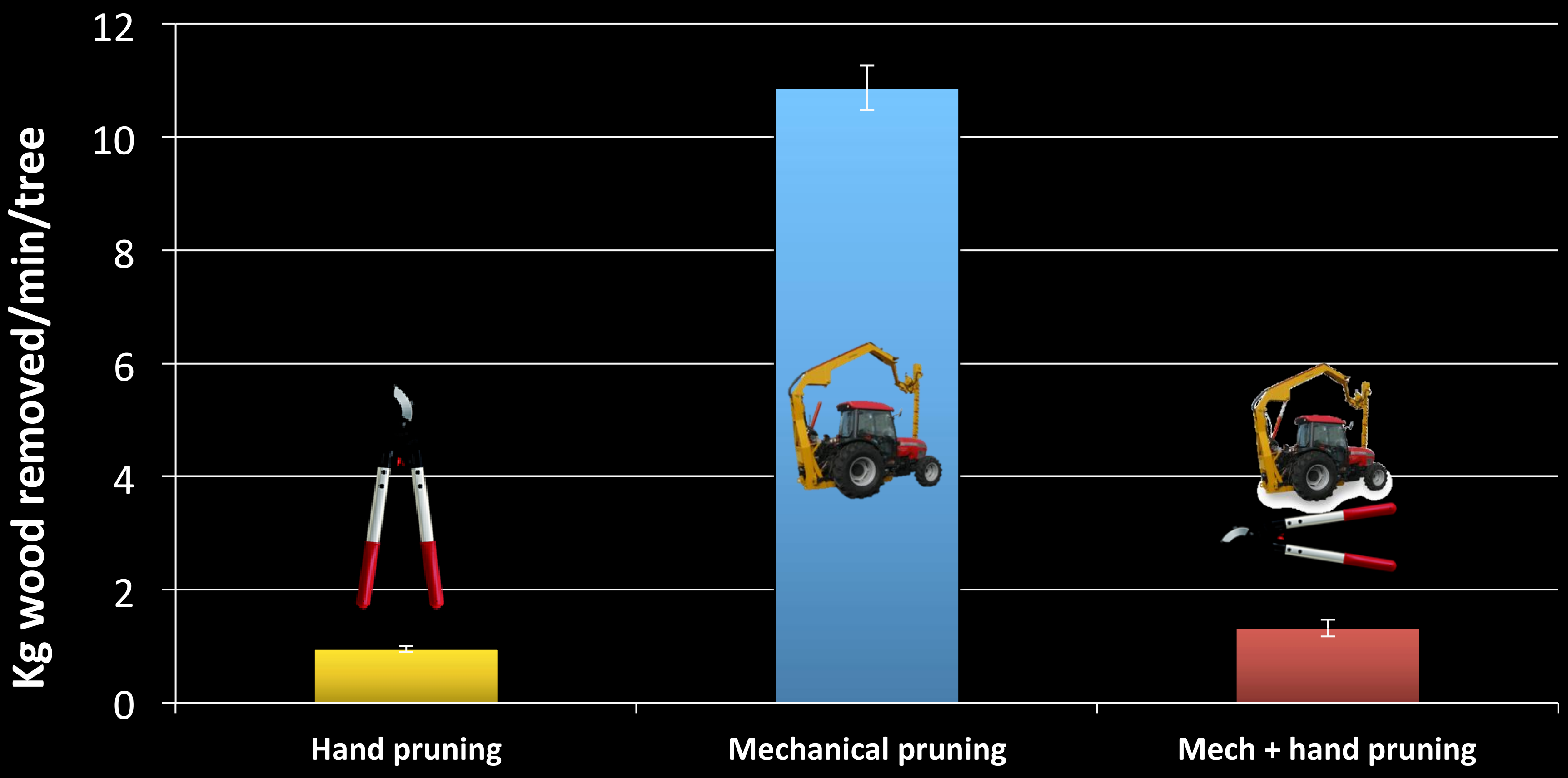
1. Hand pruning
2. Mechanical pruning
3. Mechanical pruning + Hand pruning

Results: Time



- Mech pruning 23 and 29 times faster than hand pruning (hedging and topping) in 2014 and 2015
- Combination of manual and mech. pruning was twice as fast as hand pruning (ca. 2.0 km/h)

Results: Efficiency 2015



- Mech + hand pruning was 66% more efficient than hand pruning alone
- Mech pruning was 11 times more efficient than hand pruning

Results: Yield and fruit quality 2015

Treatment	Weight (g)	Firmness (g/mm)	SS (%)	Diameter (mm)	Row size
Hand pruning	12.1 a	313	16.1	29.2 a	9
Mechanical pruning 1	11.3 b	302	15.7	28.3 b	9
Mechanical pruning 2	11.6 b	310	16.0	28.5 b	9
p-value (α= 0.05)	0.042	0.223	0.503	0.006	

- Hand pruning: 7.6 tons/acre
- Mechanical pruning 1: 9.1 tons/acre
- Mechanical pruning 2: 8.5 tons/acre

Before

After

Economic assessment

ASSUMPTIONS:

- 1 acre of UFO ‘Tieton’/’Gisela5’
- Full canopy
- 1350 trees/ha

1 person

8 hours work/day

$12/h

UFO pruning rules

- Hand pruning is 4x machine costs
- 2x over 2 years
- 23 ha to cover machine cost in 1 yr

Estimated pruning costs	
	$741
	$168
	$590

Trial 3: 'Rainier'/'Gisela®5'

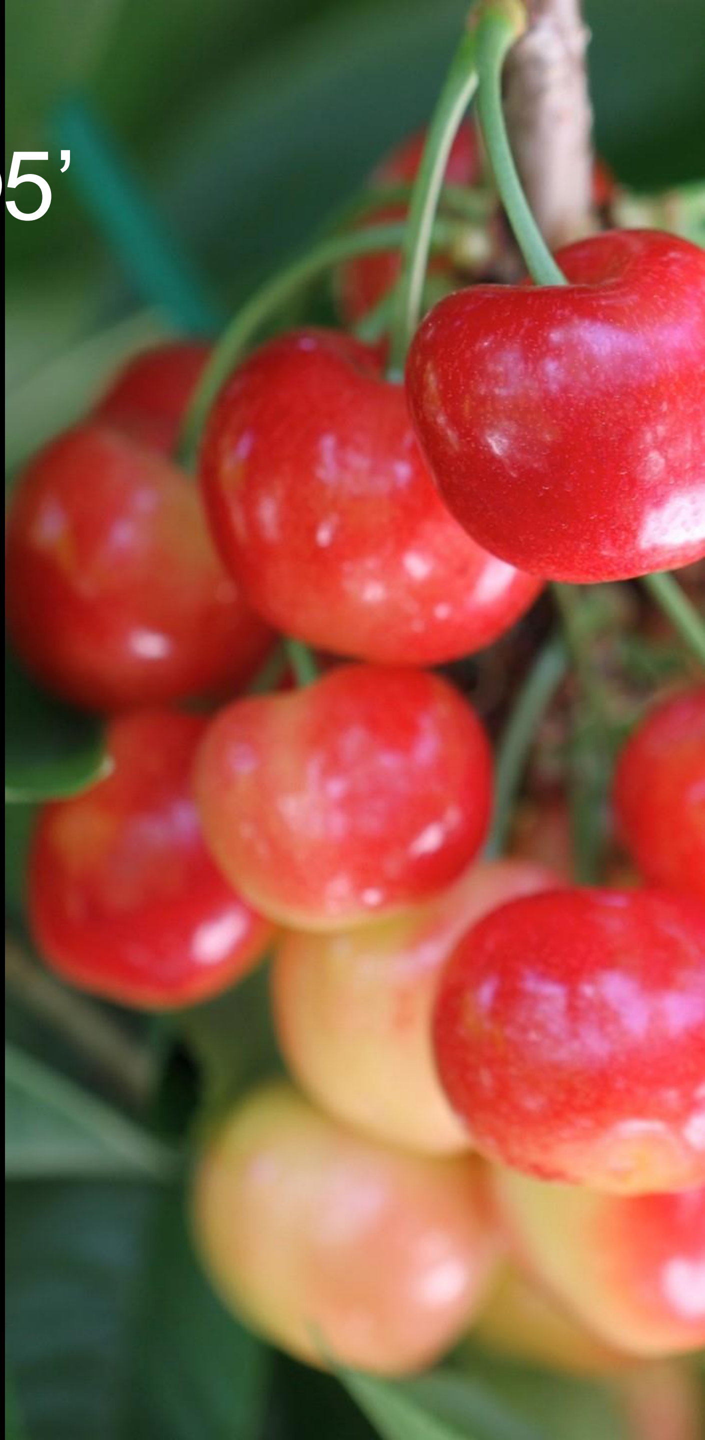
2016

- 5 reps of 10 trees
- Stihl® manual hedger

Treatments:

- Control (unpruned)
- Hand-pruned
- 20 days before harvest
- 10 days before harvest

- Yield, quality, timing, return bloom, vegetative regrowth



Results:

- Mech-assist pruning was 7 times faster than hand
- Slight improvement (+12%) in color with both timings
- Slight reduction (-9%) in soluble solids at 20 dbh
- Return bloom, regrowth TBD

Conclusion

- Adoption of innovation has been slow in cherry industry
- Market pressures will continue to force innovation
- Plan orchards to account for these challenges
- Planar, vertical or angled systems
  - Not about now, but what is next…..

FLORAL BIOLOGY AND POLLINATION SYSTEMS IN SWEET CHERRY

Matthew Whiting
Washington State University


Seattle
Washington
WSU-Prosser
Portland
© 2006 Europa Technologies
Google

Washington State University Irrigated Agriculture Research And Extension Center (IAREC)

Current/recent research projects:

- Genetic/environ. roles in fruit set/pollination
- Crop load management
- Causes of variability in fruit quality
- PGRs to improve fruit quality
- High efficiency orchard systems
- Genetic control of flowering
- Mechanizing sweet cherry harvest
- Causes & prevention of pistil doubling
- Next generation of dwarfing rootstocks
- Physiol. & hort. benefits of reflective fabric ground covers
- WA/OR breeding and genetics program
- Redefining ‘quality’ for sweet cherries - consumers

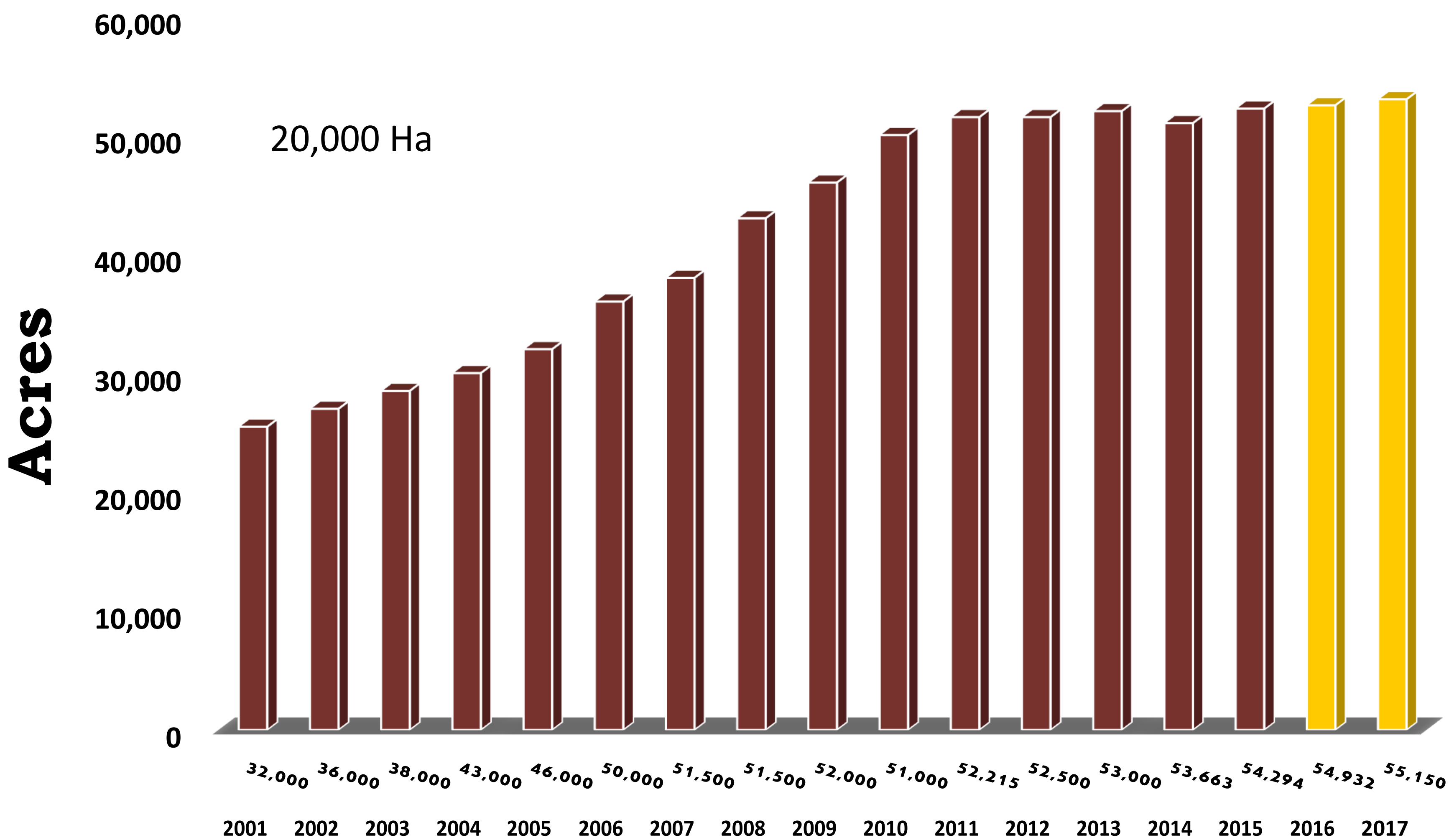
US Sweet Cherry Industry

- General characteristics:
  - Tree density: 600-650 trees/ha (increasing)
  - § Yield: 12 – 15 t/ha (50 t/ha)
  - High value specialty crop – great potential profitability: $USD 2.00 – 10.00 per kg
    - Production costs ca. $13,000+/ha
    - harvest costs ca. $0.50.kg


30-40% Export
60-70% Domestic

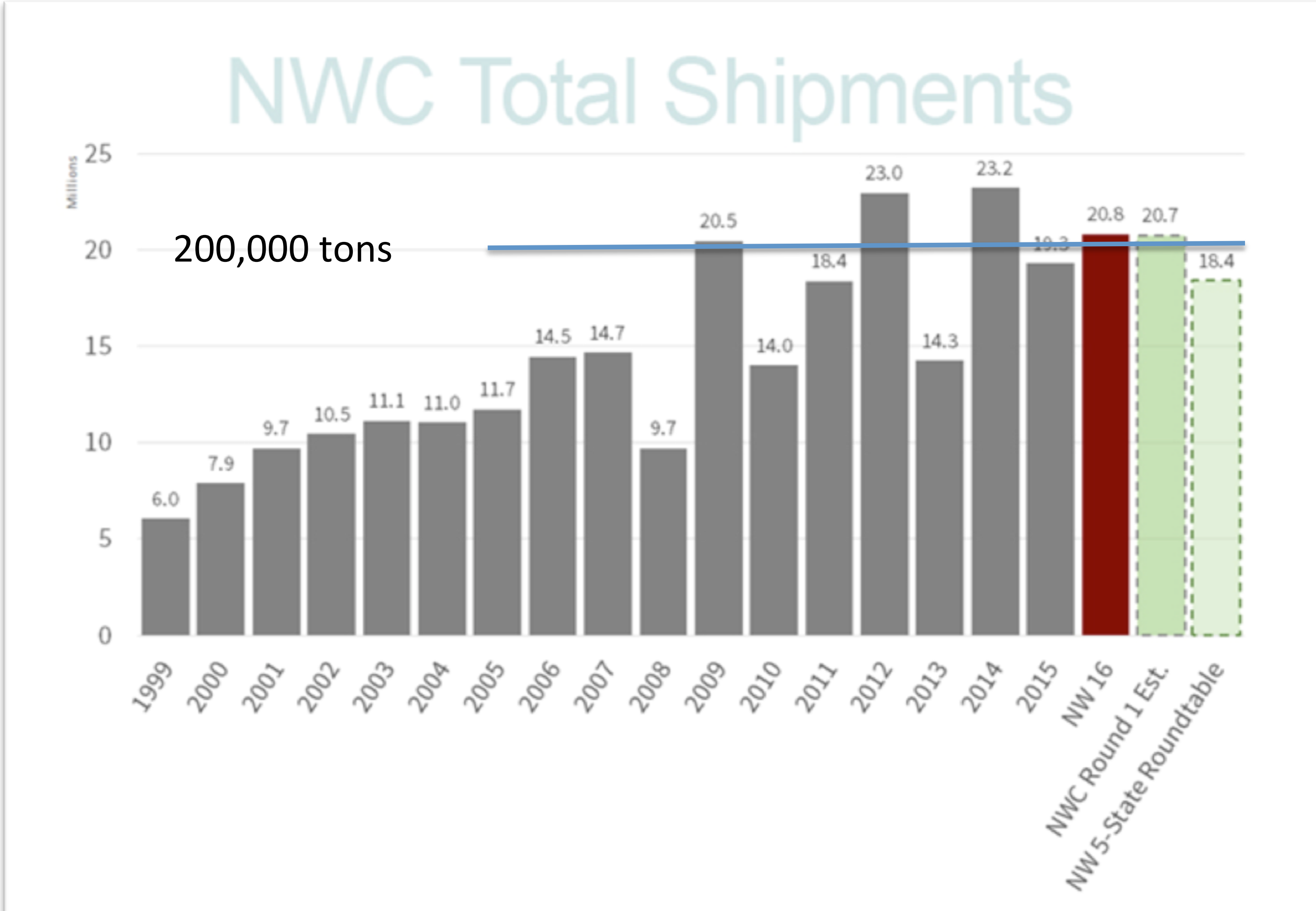
NW Sweet Cherry Acreage

(2016 Est. Oregon, Idaho, Washington, Montana, Utah)



NW Cherry Historical Shipments

(20 lb. box equivalents)



Why so concerned with pollination?

- Pollination (fertilization) is critical step determining fruit yield and quality

Yet…...

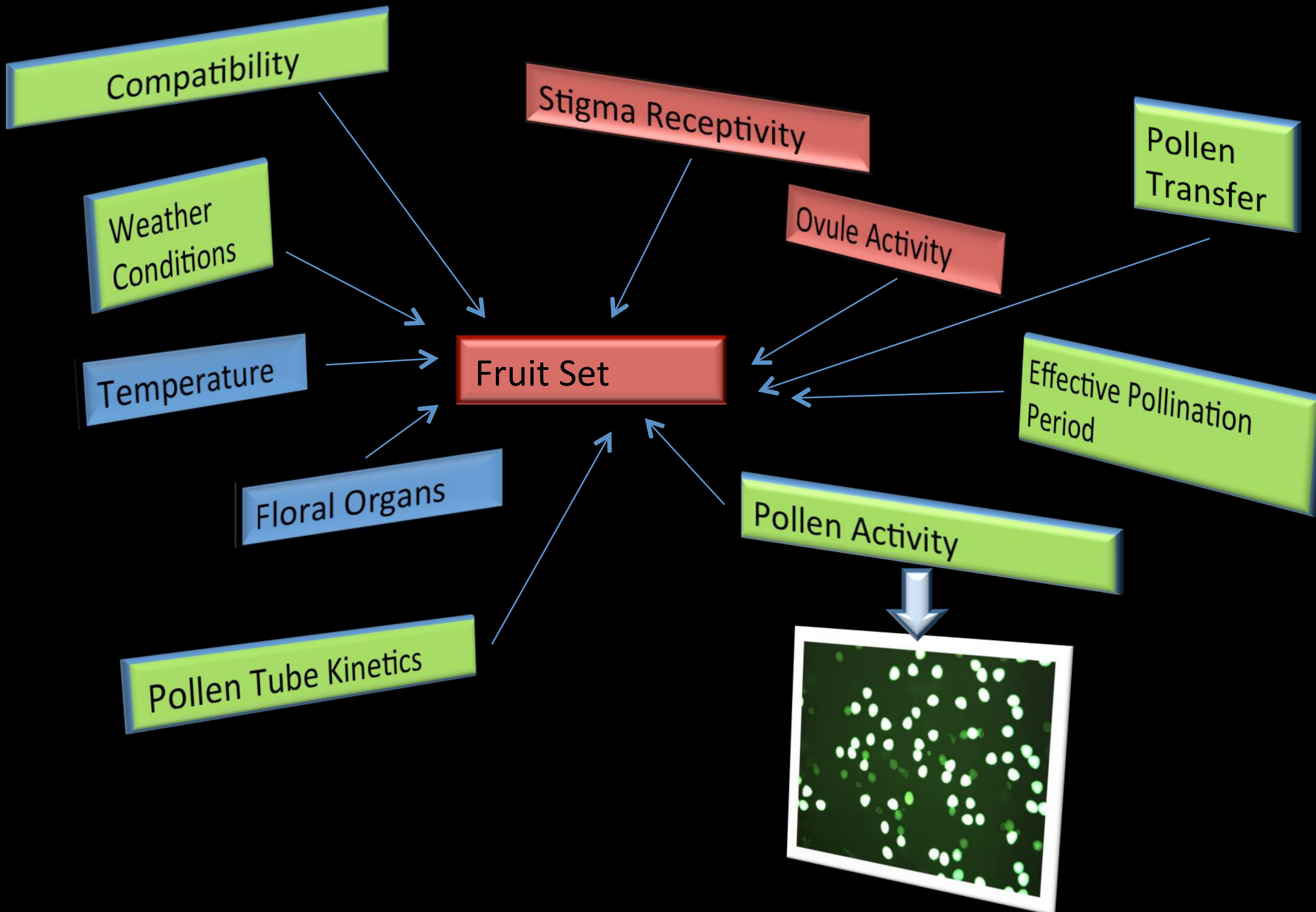
- Pollination process/system in commercial fruit crops unchanged

Growers rent hives → Flowers open → Bees collect pollen → Bees deposit pollen

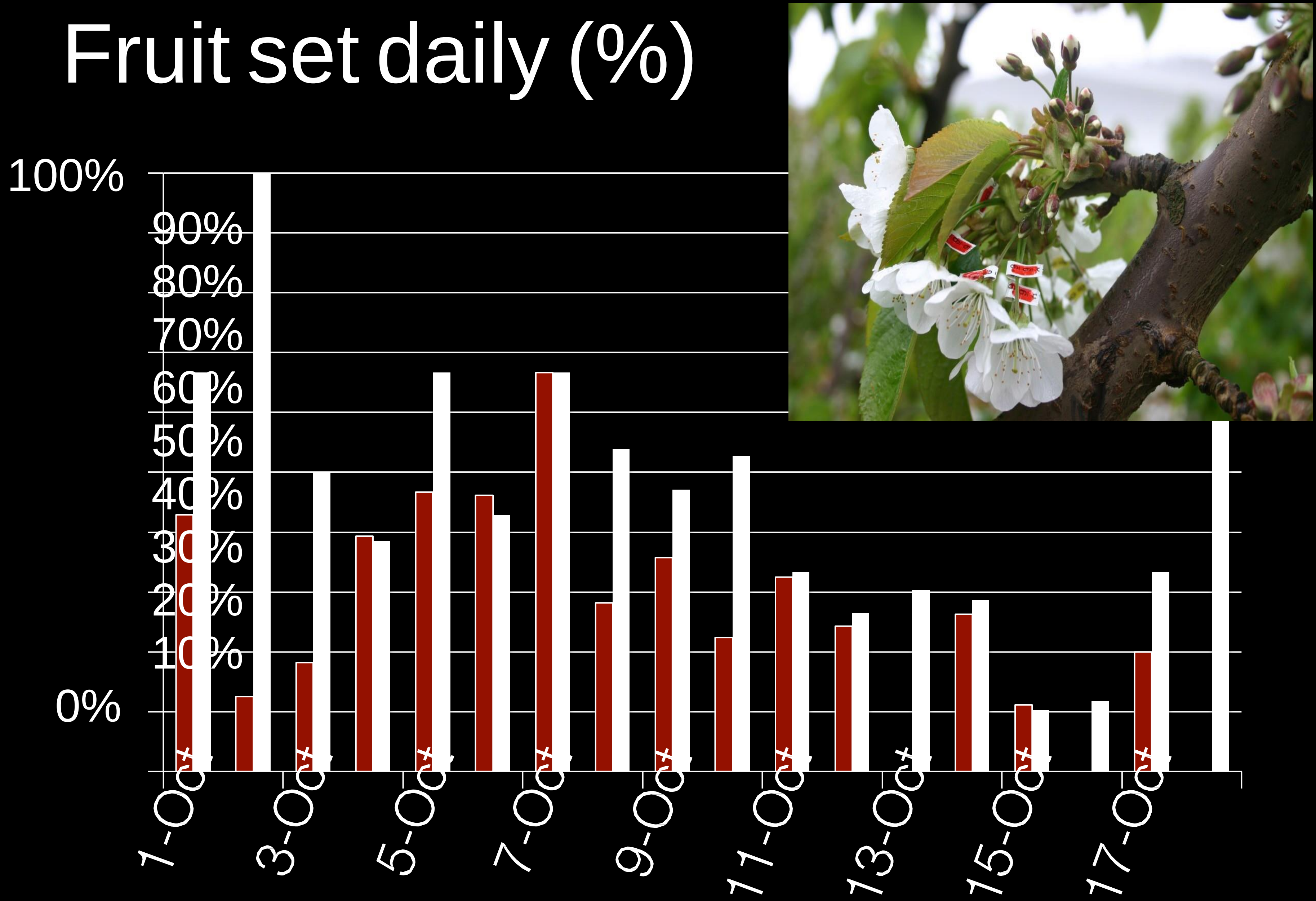
Target: high yield and quality


What factors determine fruit set (fertilization rate)?

Factors Influence Fruit Set

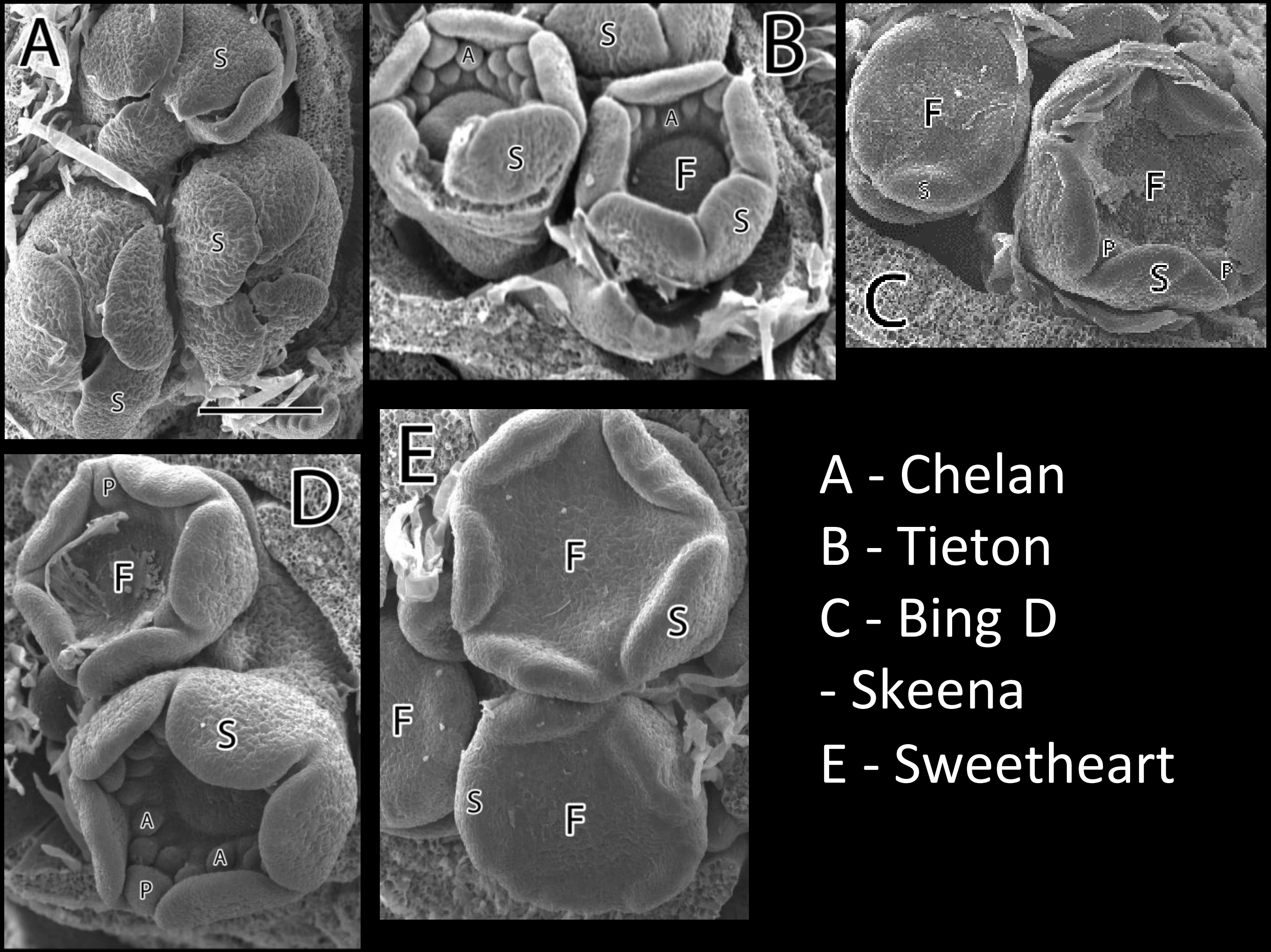


Fruit set daily (%)



Floral initiation and differentiation

17 Aug
1733 GDU



A - Chelan
B - Tieton
C - Bing D
- Skeena
E - Sweetheart

Goal: build betterbuds

Why is fruit set so variable?

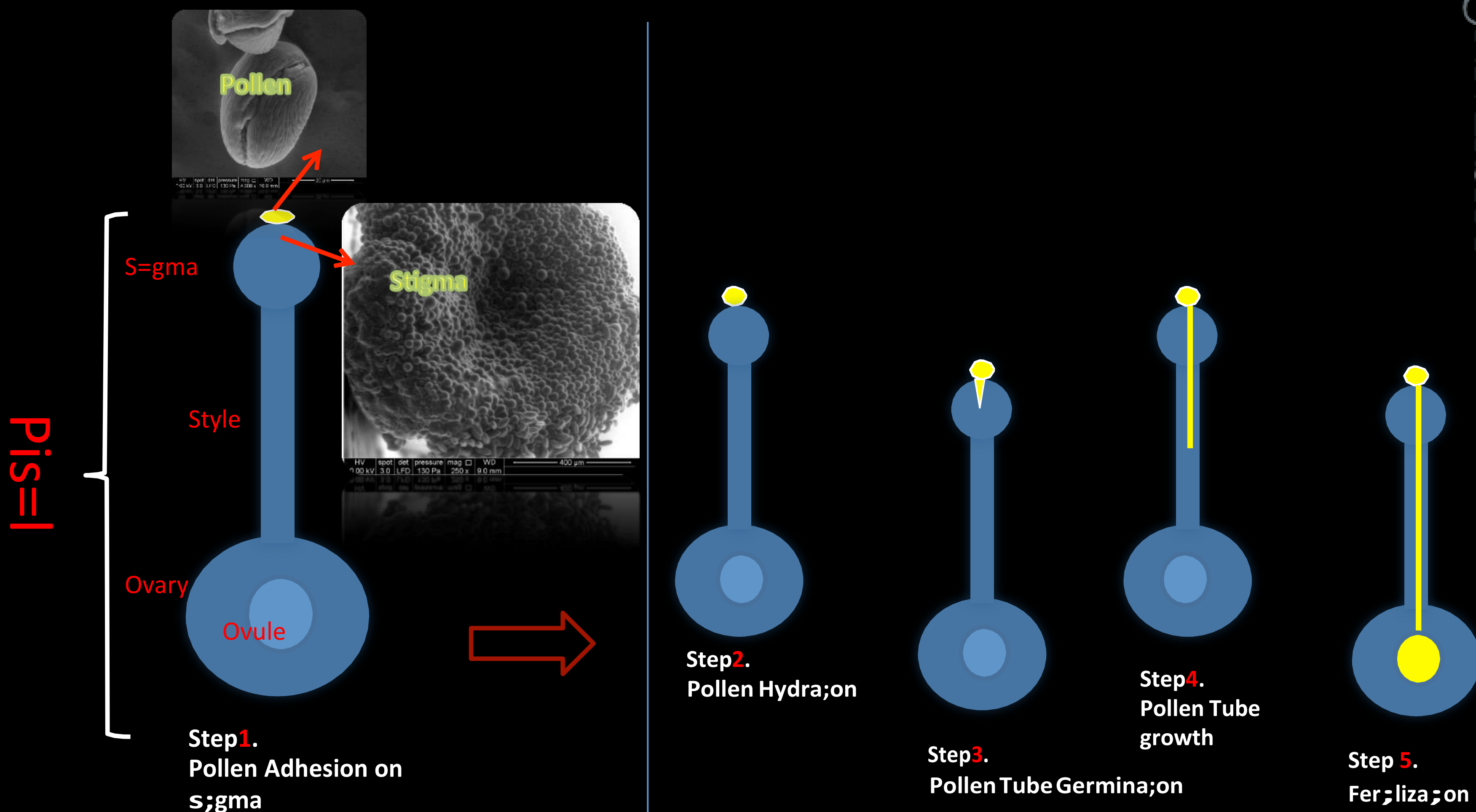
Paternal

Pollen availability
Pollen viability
Pollen growth rates

Maternal

Stigma receptivity
Ovule longevity

S=gma Recep=vity & Ovule Ac=vity



WASHINGTON STATE UNIVERSITY

Assessing the Role of Pistil in Sweet Cherry Fruit Set

In Lab

Loca;on: Prosser (WA), The Dalles(OR)

Cul;vars: Benton, Tieton, Rainier, Sweetheart

Temperatures: high, moderate and low

Pollina;on stages: 0, 1, 2, 3, 4, 5 days aOer flowering

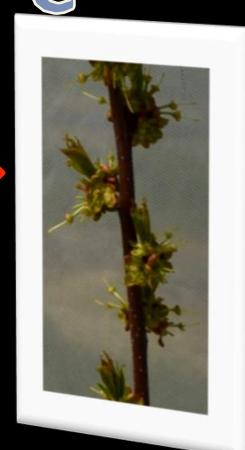
Sampling intervals: 8hr, 24hr and 48hr

S;gma recep;vity and ovule longevity were tested.

A

B

C



In field

Year: 2011, 2012

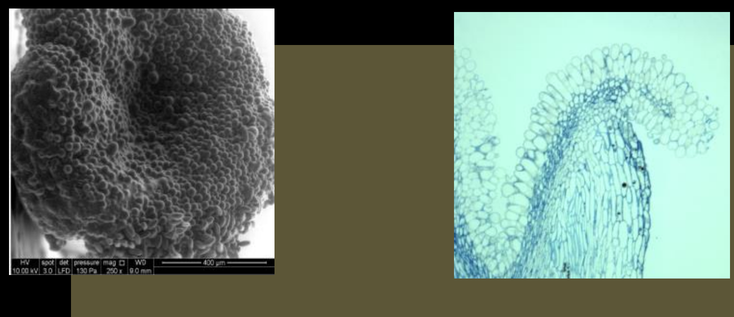
Cul;vars: Benton, Tieton, Rainier, Sweetheart

Pollina;on stages: 0, 1, 2, 3, 4, 5 days aOer flowering

Fruit set was recorded.

Stigma Receptivity

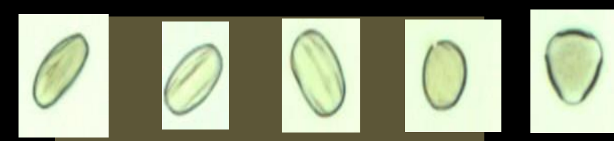
A



S=gma surface

S=gma longitudinal sec=on

B



1 2 3 4 5

Stages of pollen hydra=on *in vivo*.

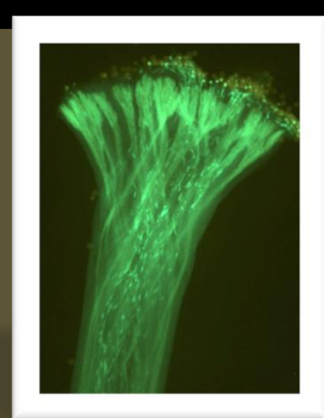
Pollen Hydra=on Level:

$$\overline{X} = \frac{\sum fc}{N}$$

$\overline{X}$: Hydra=on level
N: Total number of pollens
f: Pollen amount of different stages
c: Hydra=on stage

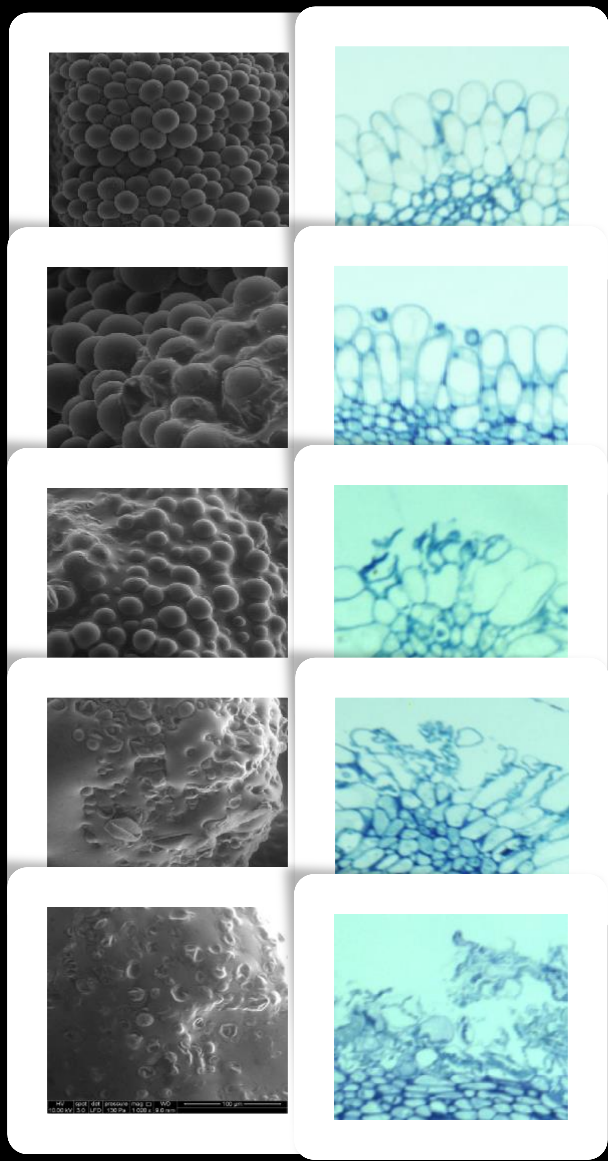
C

Pollen germina=on *in vivo*.



Pollen tube growth *in vivo*.

The Development of Stigma Surface



Days APer Opening

1 day

2 day

3 day

4 day

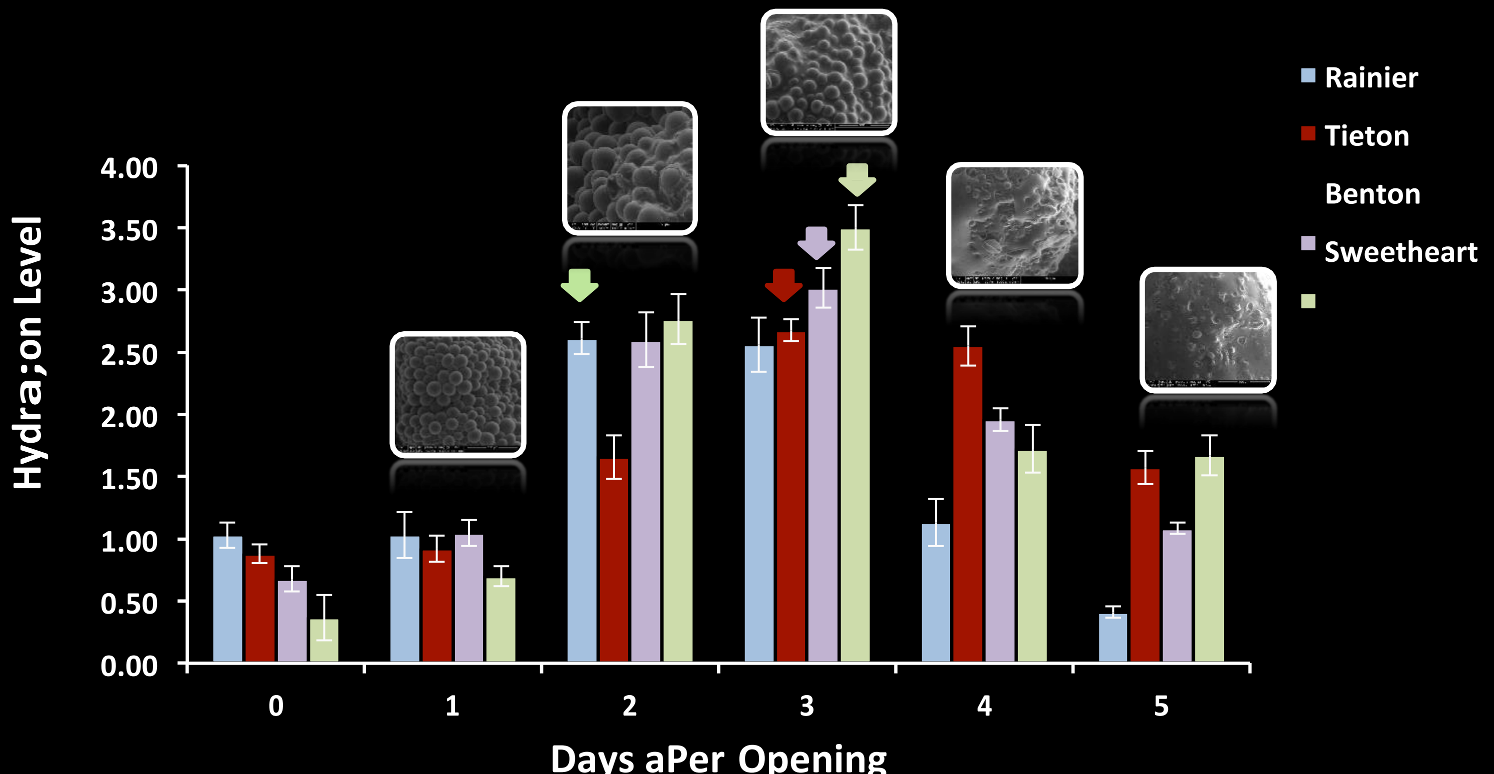
5 days

Results

No differences among genotypes

Pollen Hydration

- Flowers pollinated at 1-day intervals post-anthesis
- Pollen collected from s=gma 20 mins post-pollina=on

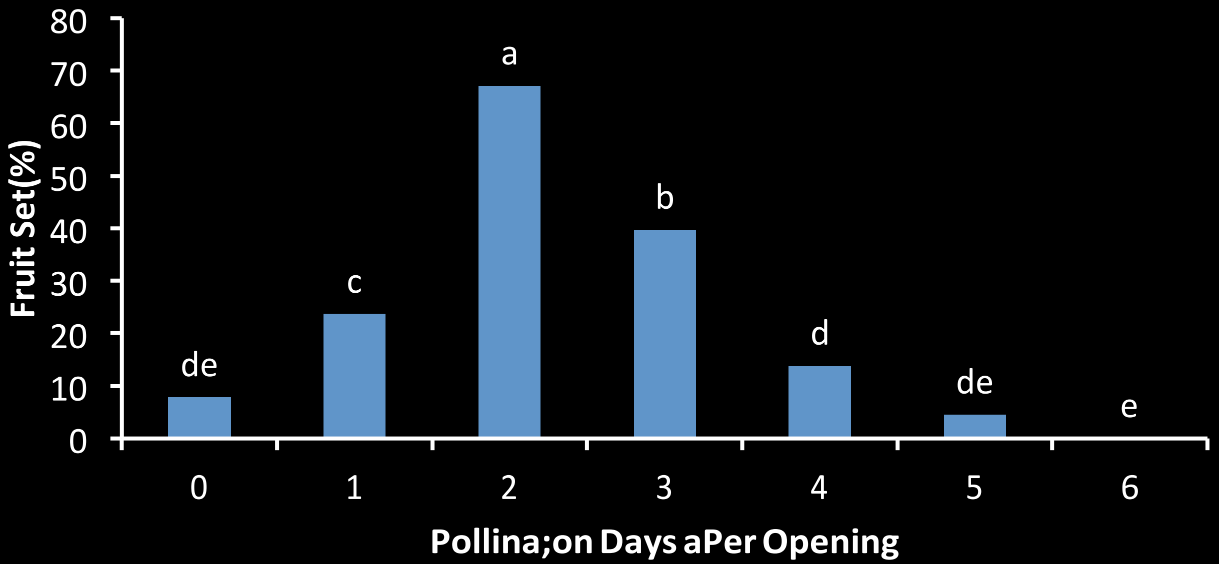


Results

No differences among genotypes

Fruit Set

•Hand pollina=ons in field at 1-day intervals
•Fruit set assessed at harvest

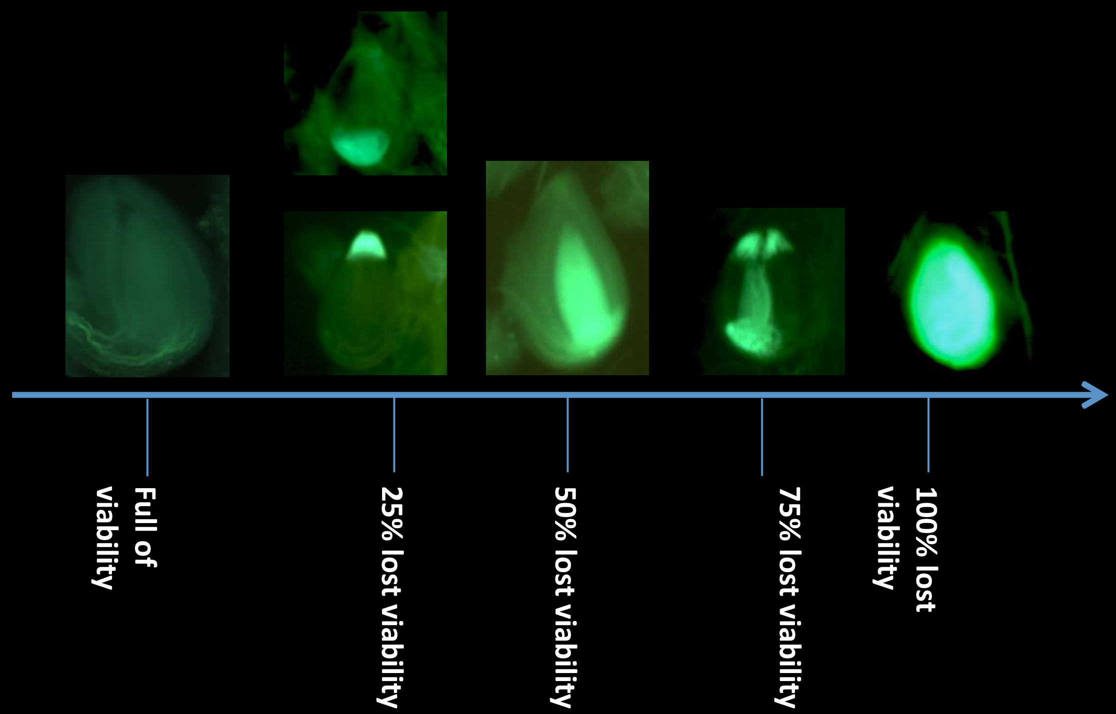


Results

- Maximum fruit set when pollinated 2 days aOer anthesis

Ovule Activity

Viability of both the primary and secondary ovules. Dead ovules appeared florescence reac=on aOer the stain of Aniline Blue.



Scales of ovule viabili=es

ReTain® (AVG) Applica=on

Goals: reduce ovule senescence and improve fruit set

Experiment 1.

Cul;vars: Tieton and Regina

ReTain® rates: 166, 333, 499 g/acre and control

Timing: '10% bloom'

Experiment 2.

Cul;var: Regina

ReTain® rates: 333 g/acre and control (water)

Timing: 'popcorn', '10% bloom', '50% bloom' and '100% bloom'

Increasing fruit set

‘Kordia’ in Tasmania

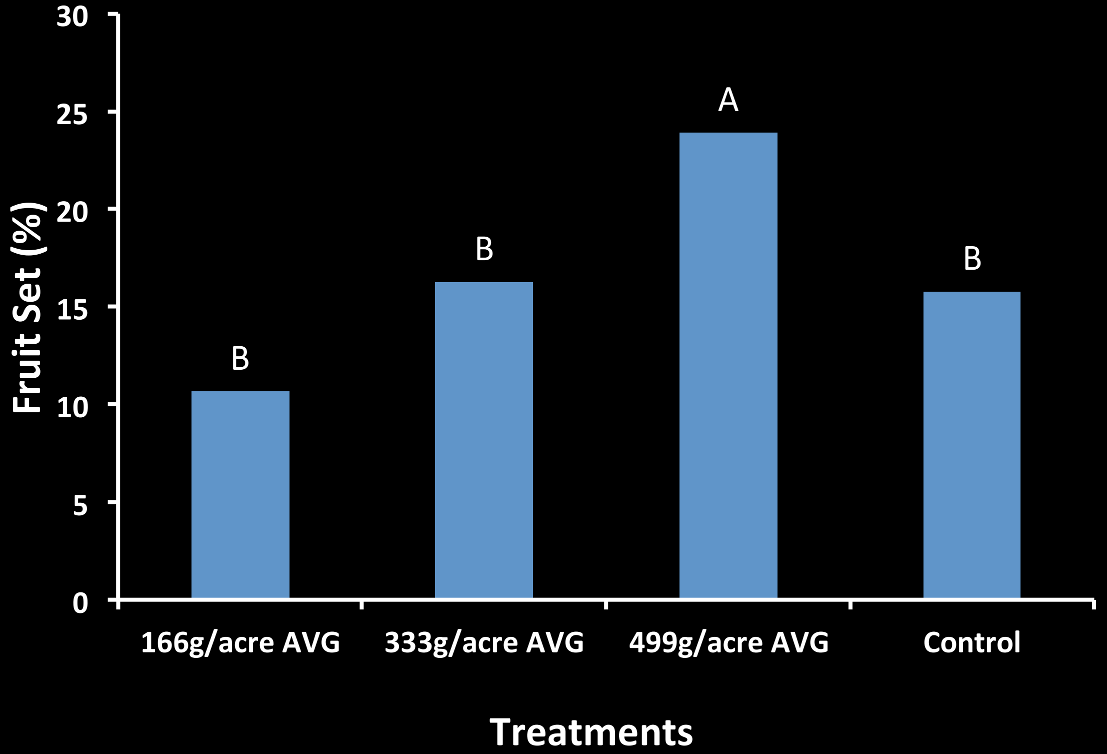
Collabora>on with Dugald Close, Sally Bound; UTas

Treatment	Fruit set (%)	Fruit wt (g)	Cracked fruit (%)
Control	9.7 a	14.5 b	25.1 b
AVG 500 g/ha	15.3 b	12.9 a	14.0 a
(ca. ¾ pouch/ac)			
Rate of AVG	ns	ns	ns
Time of applica=on	ns	ns	ns

WASHINGTON STATE UNIVERSITY

Applica=on of AVG- Fruit Set

- Fruit set increased 52% after 499g/acre AVG treatment



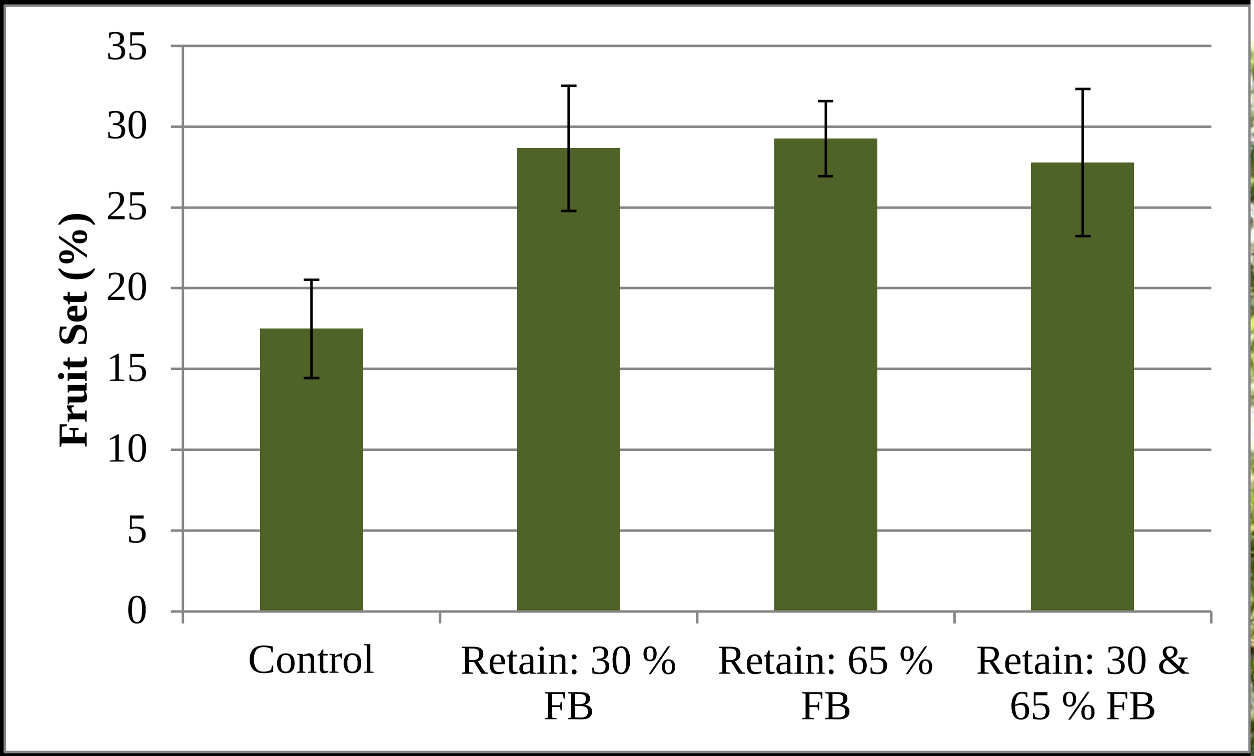
Production: 4 tons/ac
Price: $1.53/lb

yield increased 50%
→ 6 tons/ac

Income increase:
$6,000/ac

AVG Improves 'Regina' Fruit Set

Data from Todd Einhorn, OSU



- Surfactantà 0.1% v:v
- Rateà 1 pouch per ac
- Timing between 10 to 80% of full bloom

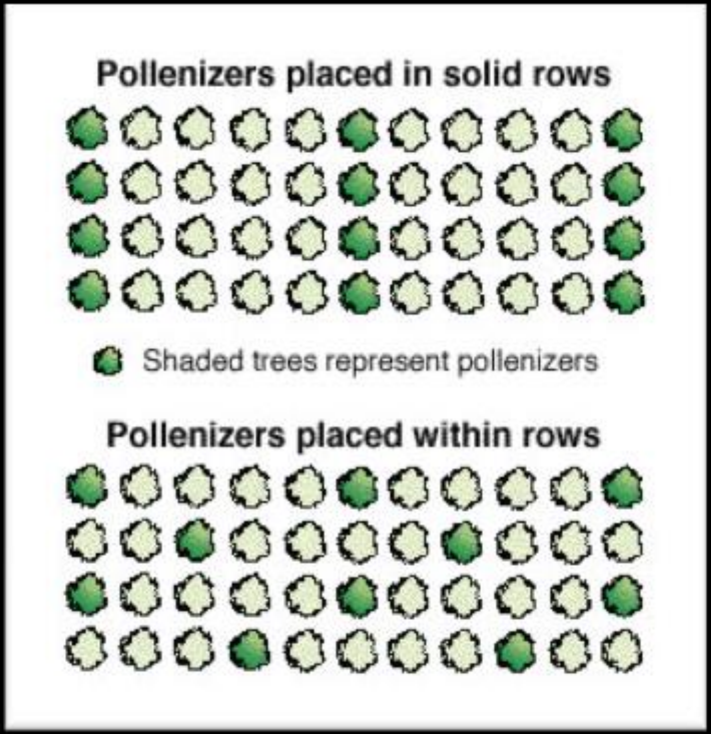
Recommendations:

- ReTain® applied at 10% to full bloom
- 333 g per acre
- Single application
- Particularly during warm weather

Need for precision pollination

Pollenizers

- Insufficient density/distribution
- Lack of overlapping bloom
- Distribution of pollen born viruses
- Harboring pests/diseases



Need for precision pollination

Pollinators

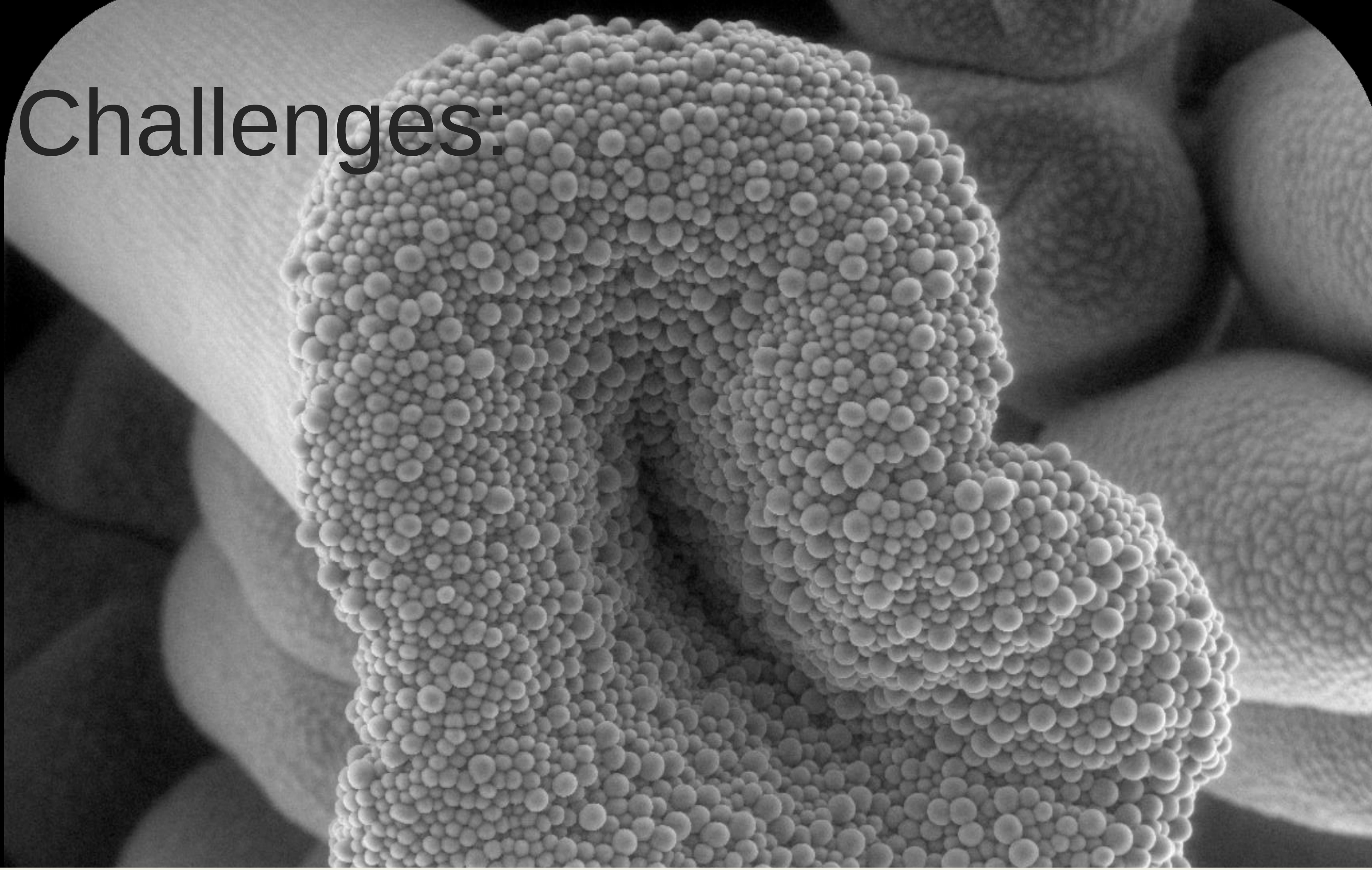
- Colony collapse disorder
- Increasing cost
- Variable colony performance
- Distribution & density
- Variable environmental conditions

Proposed solution:

1. Collect pollen
2. Suspend pollen
3. Apply pollen via sprayer

Nopollenizersnorpollinators

Challenges:

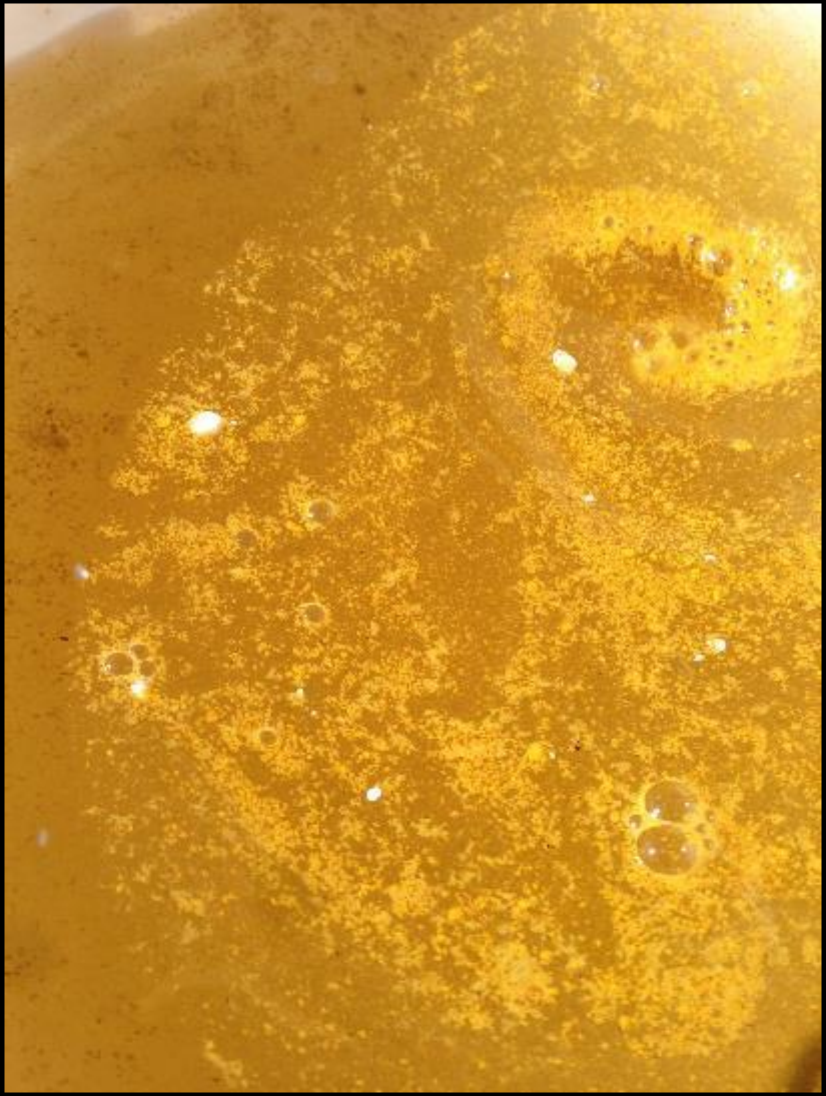


- Stigma is a small target
- Pollen loses viability in liquid
- Our vision isn’t considered ‘green’

Pollen suspension

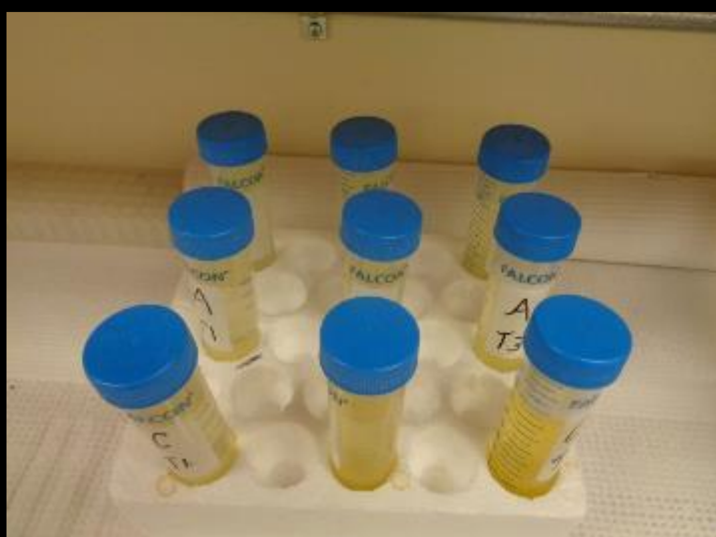
What we have learned:

- Must use pure pollen
- Pollen solubility is improved with several additions
- Can keep pollen alive for 1 hr without loss of germinability



Research approach

- 3 pollen genotypes per crop (apple, sweet cherry and pear)
- Spray at loading 5, 30 and 60 mins
- Pollen viability assessment at 6hr and 24hr

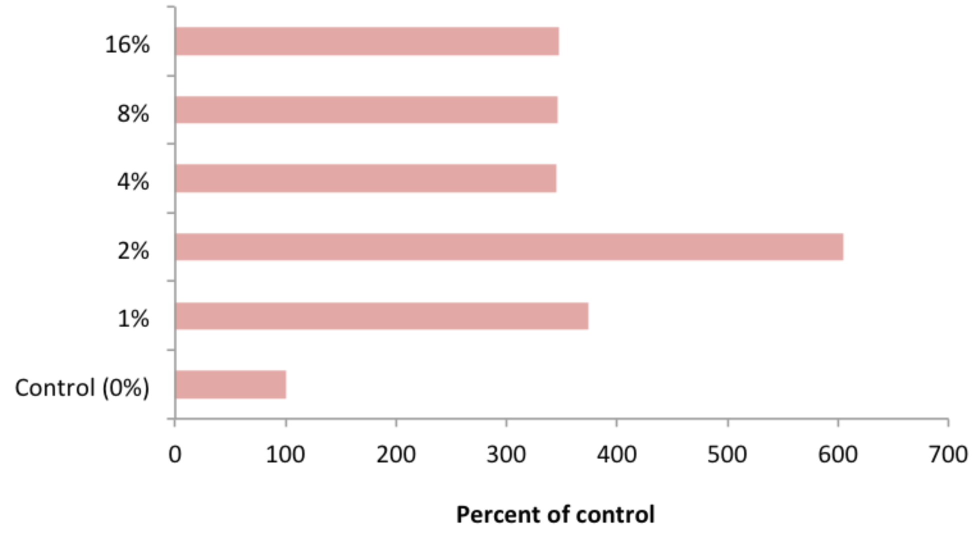


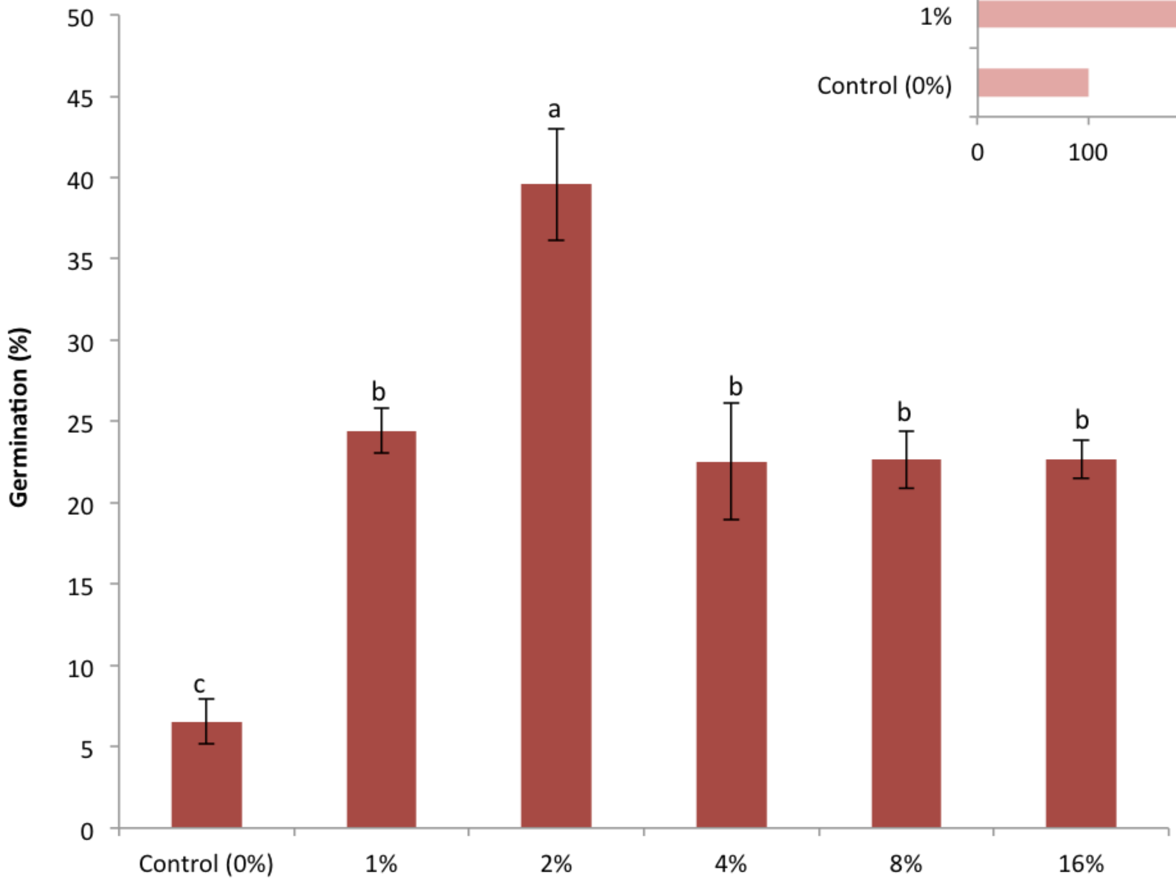
Pollen Suspension Development

Concentration Effect

Cultivar: Rainier

Incubation period: 60 minutes



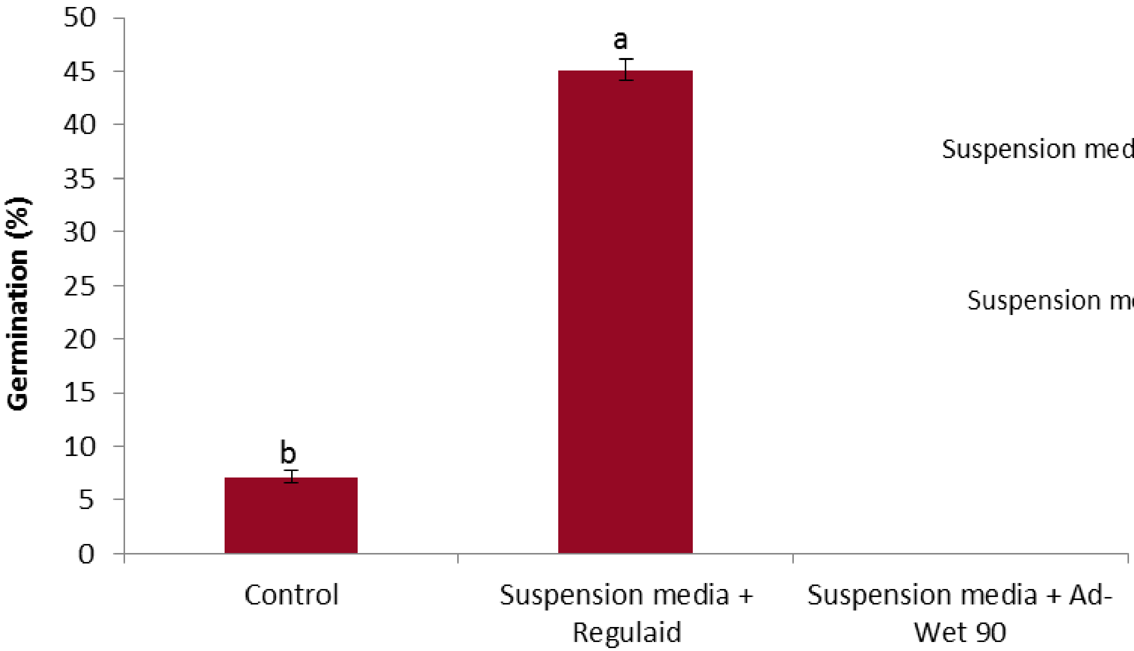


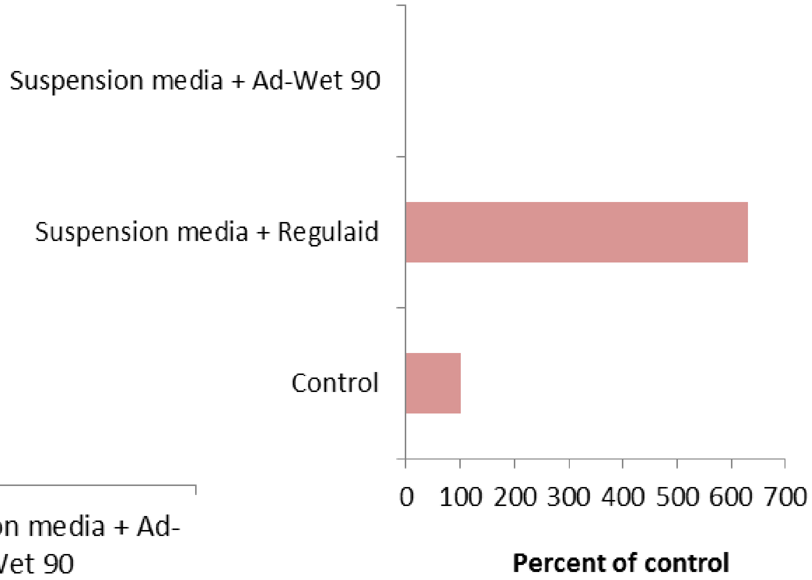
Pollen Suspension Development

Composite solution
with surfactants

Cultivar: Rainier

Incubation period: 60 minutes

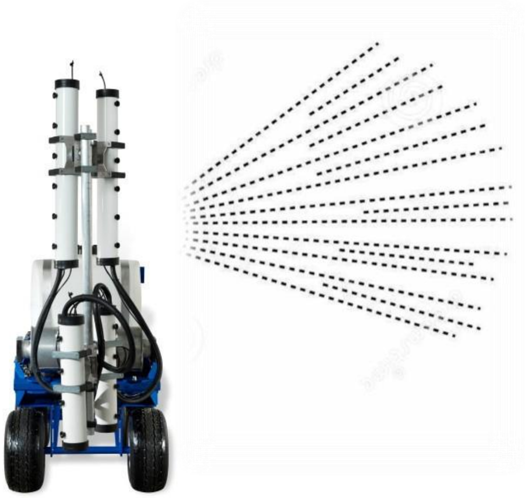




Pollen application

Spring 2014

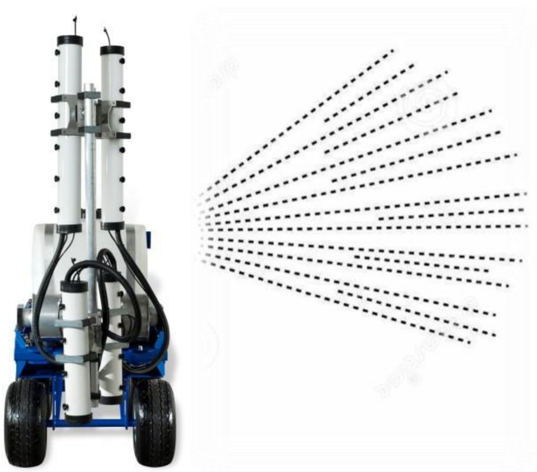
- Pollen
- Proprietary slurry



Viscous droplets

Spring 2015

- Pollen
- WSU-developed slurry



Non-viscous & fine droplets

Electrostaticsprayer

On Target Spray Systems

Low volume applications (95-110 L/ha)

Precision pollination

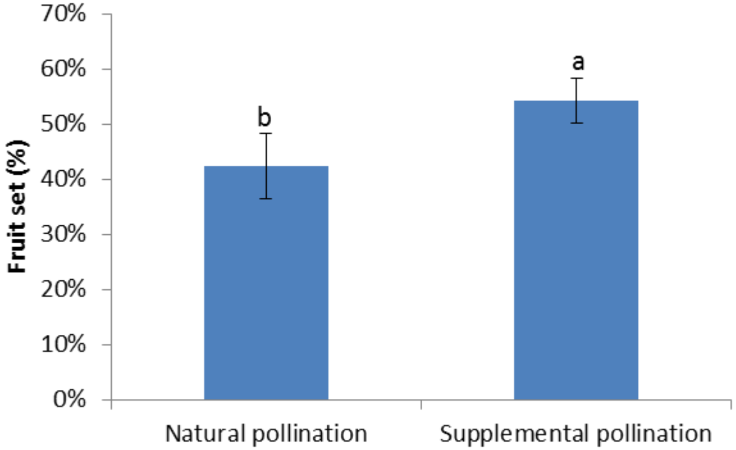
Results: Spring 2014

Cultivar: Tieton/Gi®5

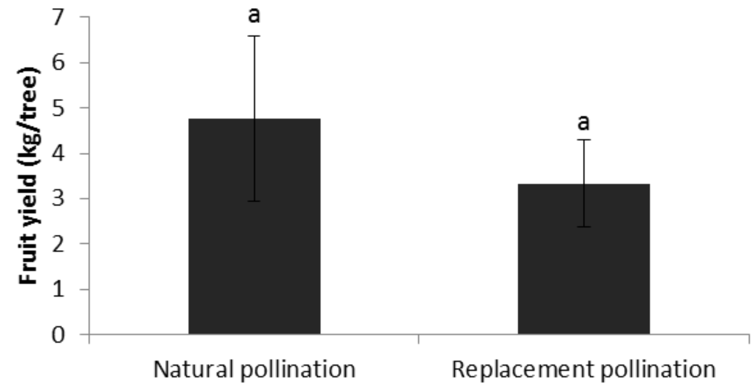
Cultivar: Bing/Gi®6

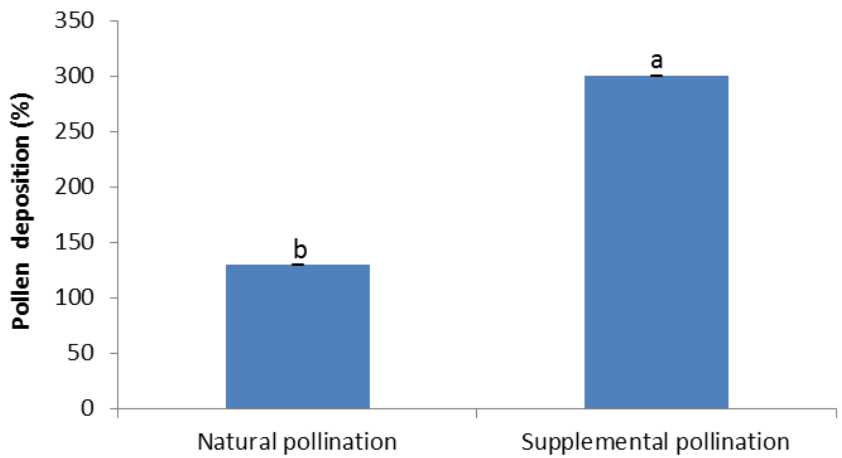
Reps: 10 limbs/treat.

Supplemental



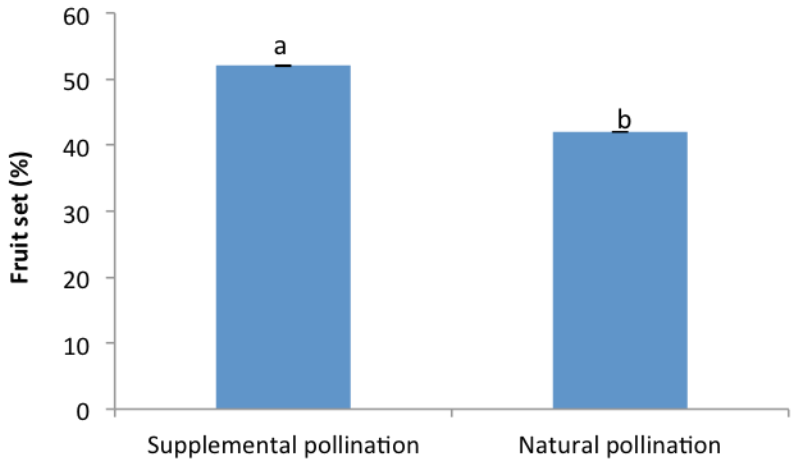
Replacement

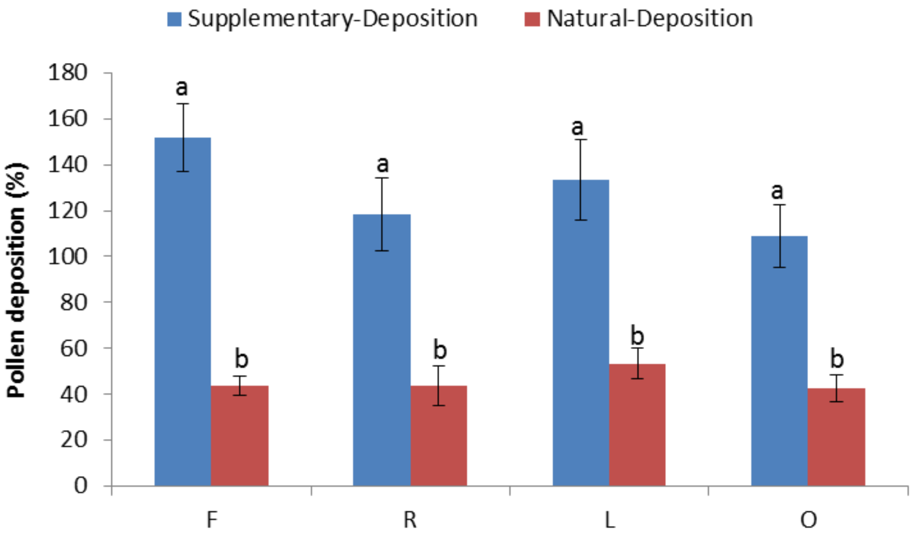


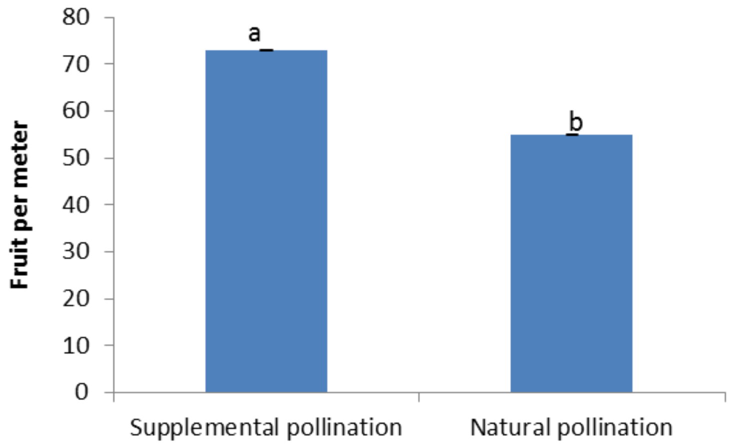


Results: Spring 2015

Tieton/Gisela®6

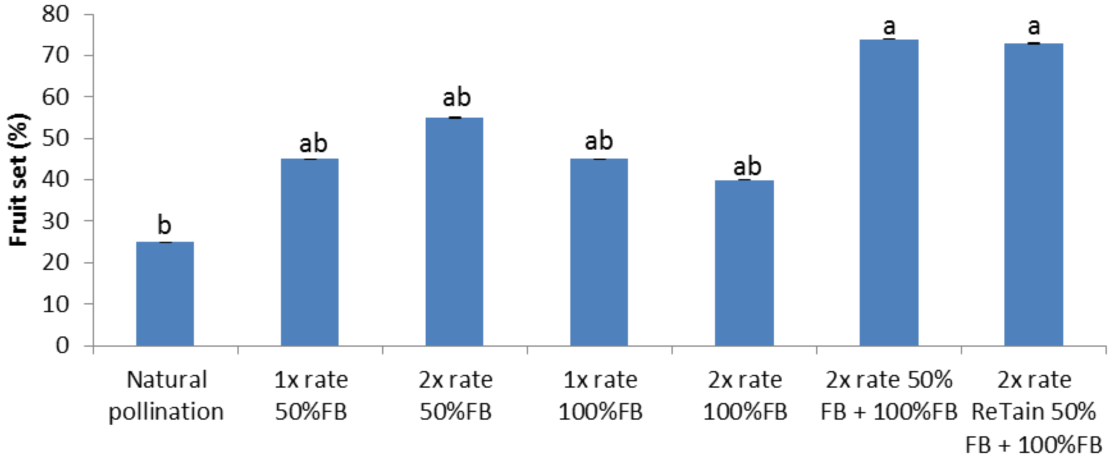


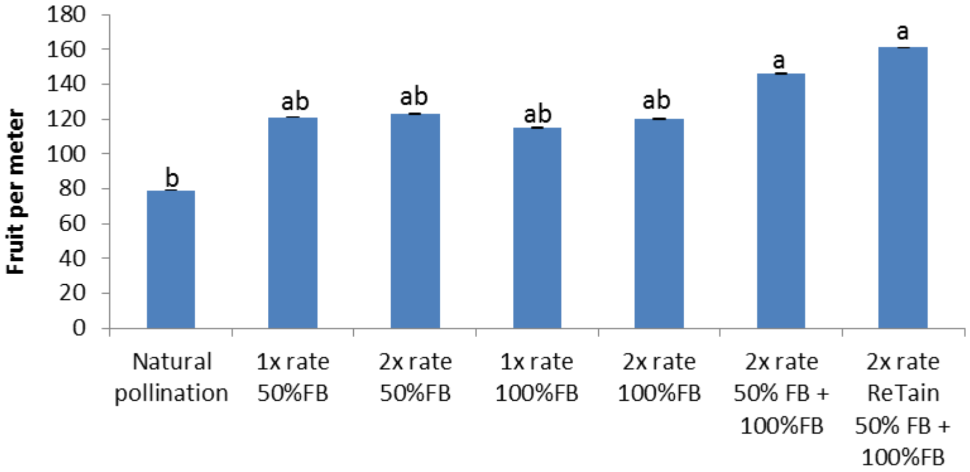




Results: Spring 2015

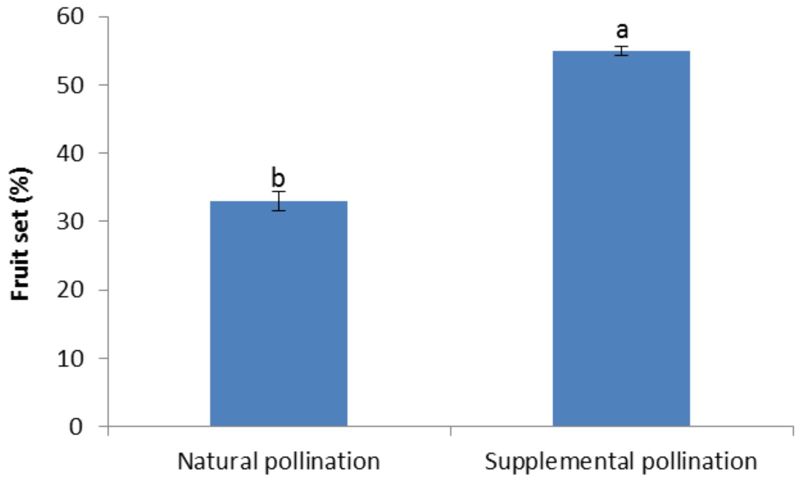
Early Robin/Gisela®12

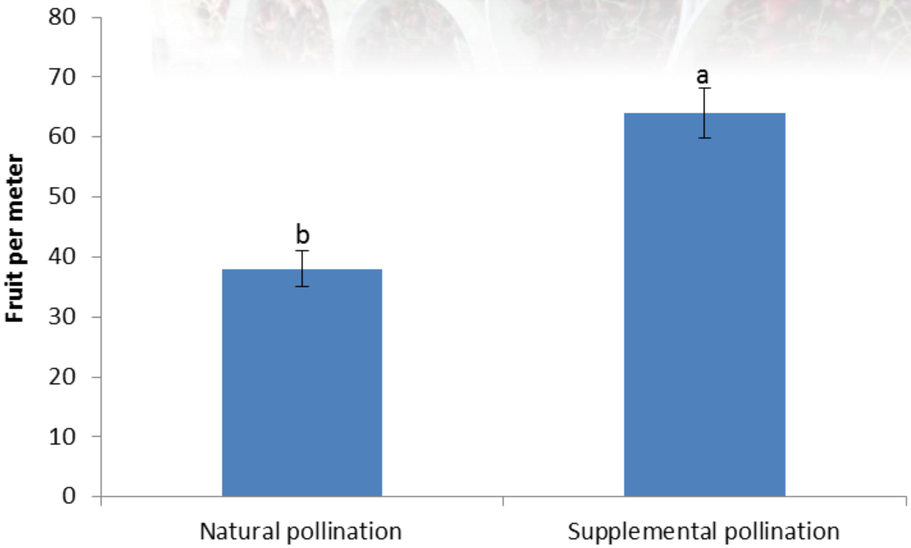




Results: Spring 2015

Regina/Mazzard®





Summary

- Fertilization (pollination) is fundamental toproductivity & profitability
- Perennial challenges with pollenizers & pollinators
- Our vision:
  - Precision pollination systems for yield security & resilience to threats

Key results

- New suspension solution performed well with electrostatic application system
- Supplemental pollination increased fruit set in every trial (sweet cherry, pear, apple)
- Further research necessary to:
  - Refine timing and rate of pollen
  - Improve suspension
  - Improve pollen collection systems
  - Control nozzles to target applications & save pollen

Future orchard systems:
Precision pollination for consistent, balanced

mdwhiting@wsu.edu

FB: WSUStoneFruitPhysiology

National Cherry Development Program

Cherry Road Show 2016

By R.J. Nissen

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Who is Bob Nissen?

- Substantial experience in project development, conducting, monitoring and evaluating projects in agribusiness, horticultural production systems
- Conducted research for greater than 30 years in plant physiology/agronomy of temperate fruits tree crops, vines crops and their adaptation to subtropical and tropical environments
- Conducted research on floral biology, tree architecture, canopy management, nutrition and irrigation and nursery management systems, postharvest management systems, value chains and extension methodologies of temperate, subtropical and tropical tree crops in Australasia and Oceania
- Designed training programs and trained numerous framers and value chain actors in Australasia
- Mentored and supervised PhD, Masters and undergraduate students in aspects of horticultural production, postharvest systems, value chains in Australasia and the Pacific
- Part of the TIA PHC team focusing on assisting Tasmanian horticultural industries to enhance their farming systems to increase domestic and export markets, and remaining economically and environmentally sustainable

National Cherry Industry Development Program

- 4 year program
- designed to raise awareness of cherry research
- development and build capacity in the Australian cherry industry.
- program direction is determined through regular consultation and input from growers through state representatives
- identify knowledge gaps or highlight priorities and problems that occur in growers regions
- On farm grower level field day activities, through formal and informal presentations, training and workshops
- Activities have occurred in 5 states (NSW, VIC, TAS, SA and WA)

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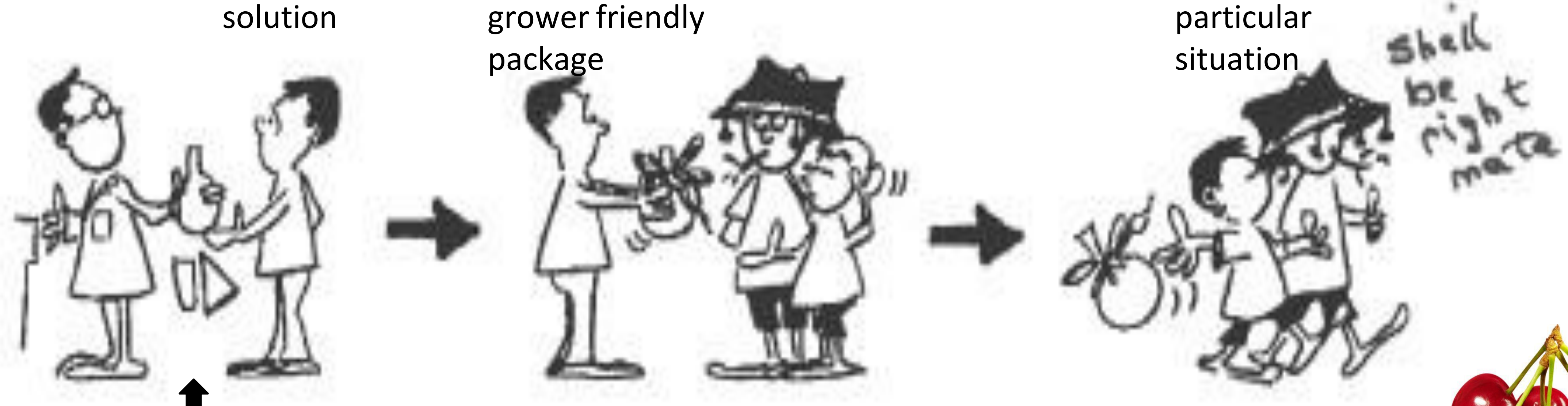
By R.J. Nissen

National Cherry Industry Development Program

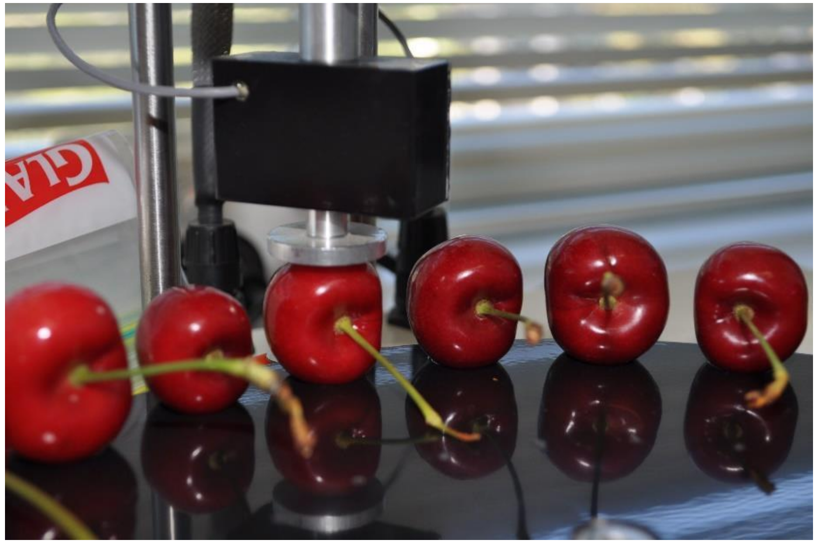
Past research & extension activities

Researcher develops a solution to an issue → The extension officer then receives the solution → The extension officer then codes the solution into a grower friendly package → The package is then transferred to the grower → The grower thinks the package is not correct for his particular situation



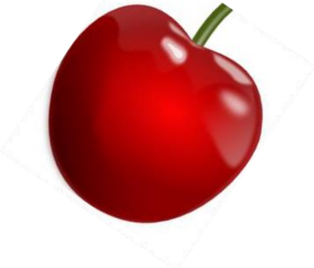
Grower issues

National Cherry Industry Development Program



Suggestion?

- New Proposed Program
- We here to help you – a new process?
- Future Cherries Program
  - Small regional self directed groups are set up
  - These groups are facilitated and assisted
  - These groups set their own agenda based on their own regional issues
  - Small pilot projects are set up to solve these regional issues
  - Projects are analysed and evaluated by the local group members
  - Project results are disseminated to all local growers by the group members



By R.J. Nissen

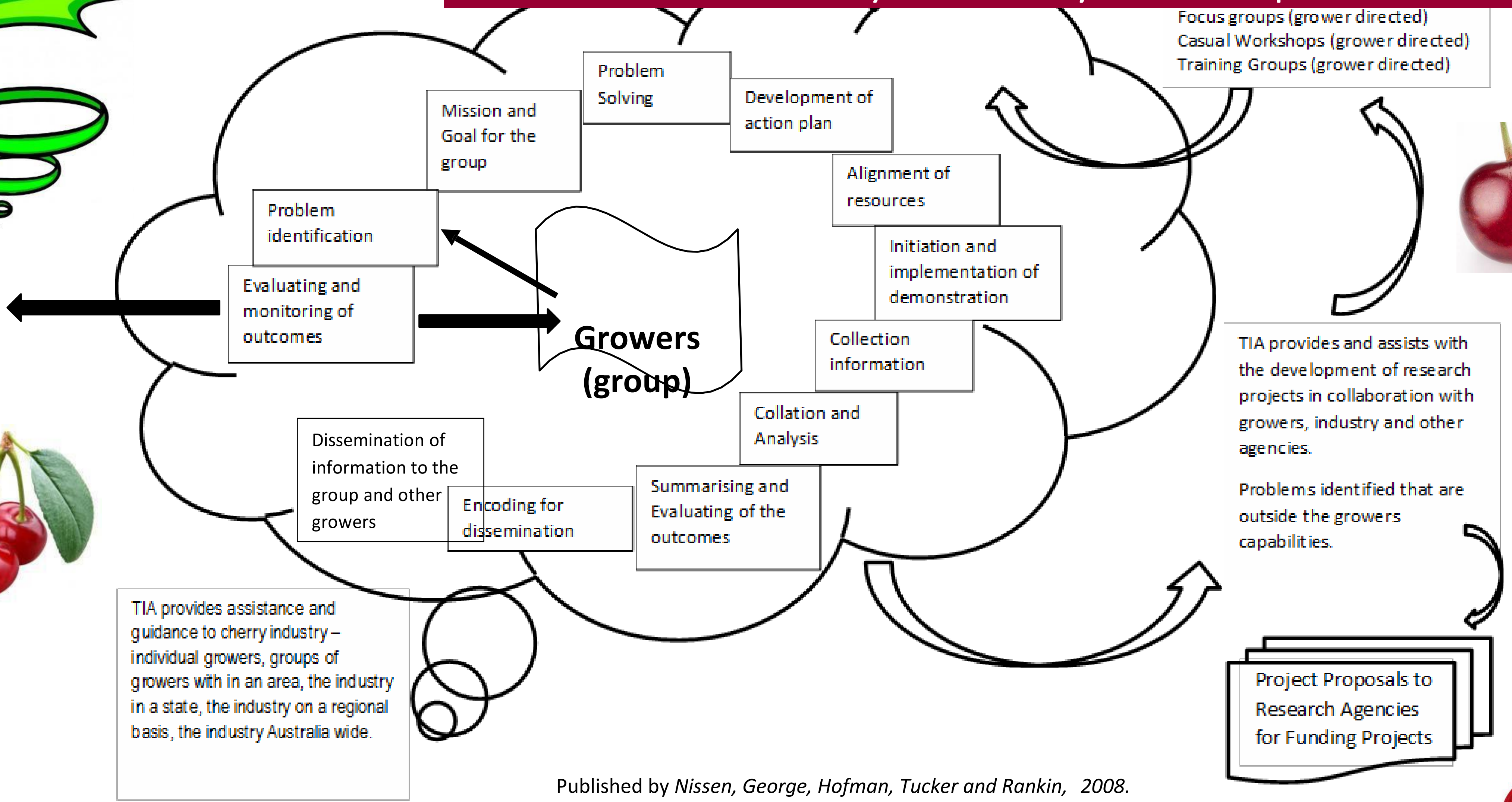
Capacity building for Australian Cherry Growers

- Participatory Action Learning Process (PALP)
  - Consultations-listening, learning, then assisting to realise regional/ industry goals
  - Casual training workshops-grower directed, on-farm in-field informal and formal demonstrations
  - Growers-problem identification, problem solving, design, resource and implement projects, conduct the analysis, evaluation. All stages are implementation by growers and then monitoring of outcomes

- Work-Learn, work-Learn process
  - Practical hands on problem solving process implementation (work phase)
  - Monitoring, analysis, evaluation and reflection (learning phase)

By R.J. Nissen

National Cherry Industry Development Program



Published by *Nissen, George, Hofman, Tucker and Rankin, 2008.*

PALP process for grower self-directed groups (Groups within an area, an area, state, regional or the Australian industry as a whole) to build their capacity

By R.J. Nissen

National Cherry Industry Development Program

PALP and work-learn-work-learn sessions

- Under the participatory action learning process (PALP)
  - Growers are placed in self directing groups
  - All growers have part ownership of the research conducted
  - All growers participate in the research
  - All growers are professionally assisted during the PALP and work-learn-work-learn
    - Assistance and help is provided at every step-when requested
  - Issues identified can be with in a location, area, state, region and Australia wide
  - This assists in building grower capacity to improve knowledge, confidence and ability to correctly identify issues and correct them.

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Grower discussion and feedback session

- PALP and work-learn-work-learn sessions
- Under the participatory action learning process (PALP)
  - Growers are placed in self directing groups
  - All growers have part ownership of the research conducted
  - All growers participate in the research
  - All growers are professionally assisted during the PALP and work-learn-work-learn
    - Assistance and help is provided at every step-when requested
  - Issues identified can be with in a location, area, state, region and Australia wide
  - This assists in building grower capacity to improve knowledge, confidence and ability to identify issues and correct them.






Questionnaire

- Short questionnaire
- 9 Questions
  - Circle options
  - Provide comments and feedback on this National Cherry Industry Development Program
- Questionnaire time 10 minutes max

National Cherry Industry Development Program

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Thankyou Ladies and Gentleman

Horticulture
Innovation
Australia

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Washington
State
University

Cherry Innovations®

Cherry Road Show 2017

By R.J. Nissen & Matt Whiting

Future Cherry Orchards

Washington State University

Key Production Trends ?

Yield

Quality

Costs

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To remain competitive the cherry industry must improve efficiency

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Future cherry orchards

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- Economically Profitable
- Environmentally sustainable
- Right cultivars
- Planted in the right location
- Grown with the right management/cultural practices
- Targeted at specific markets
- Stable yields & balanced production
- Produce high quality fruit, marketability & storability
- Efficient and effective production & marketing systems

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Washington State University

USA

Washington State University

USA

UNIVERSITY of TASMANIA

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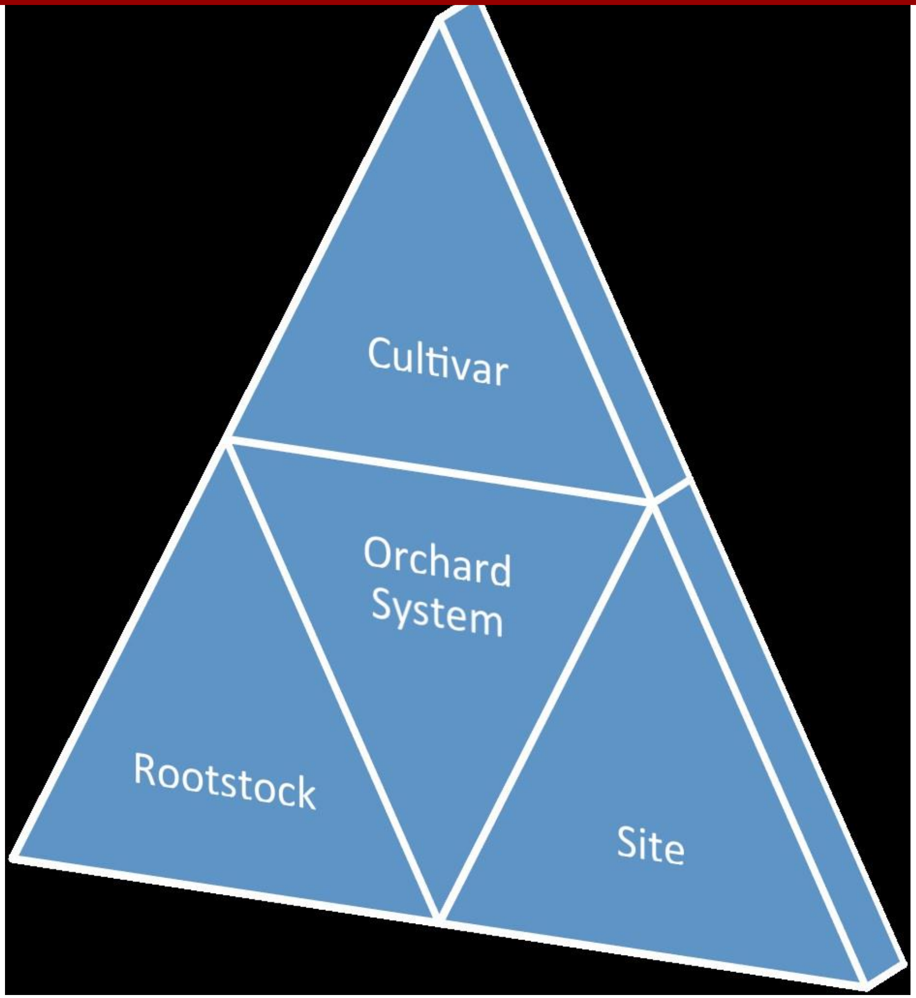
Key components of future cherry orchards

Washington State University

- Profitable & sustainable
- Precious & constantly productive
- Simple to manage
- Pruning & training - simple, efficient productive canopies

Ability to utilise automation & mechanisation (drive costs down)



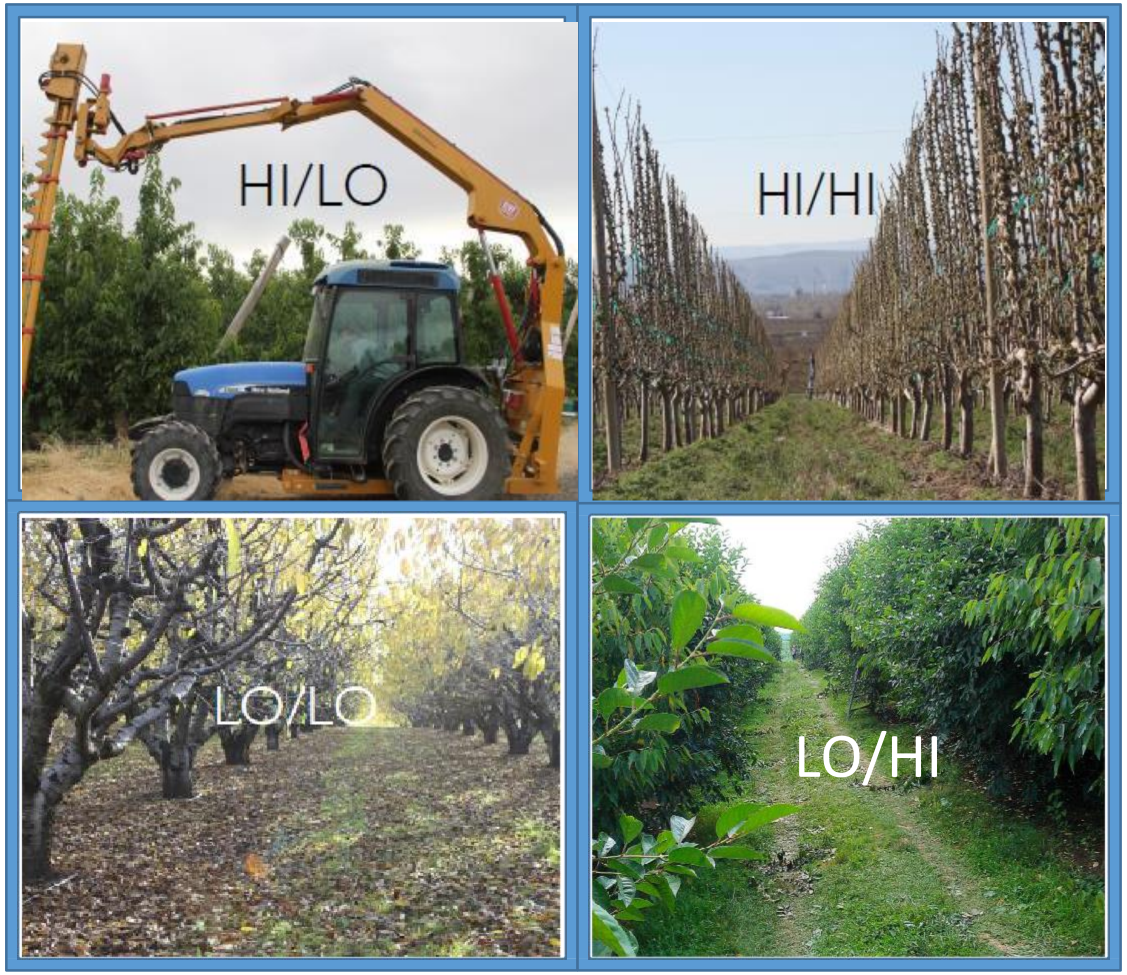
Output vs. Input

Washington State University

High

Production Systems ?

Output



Where do you want to be?

Low

Low

Input

High

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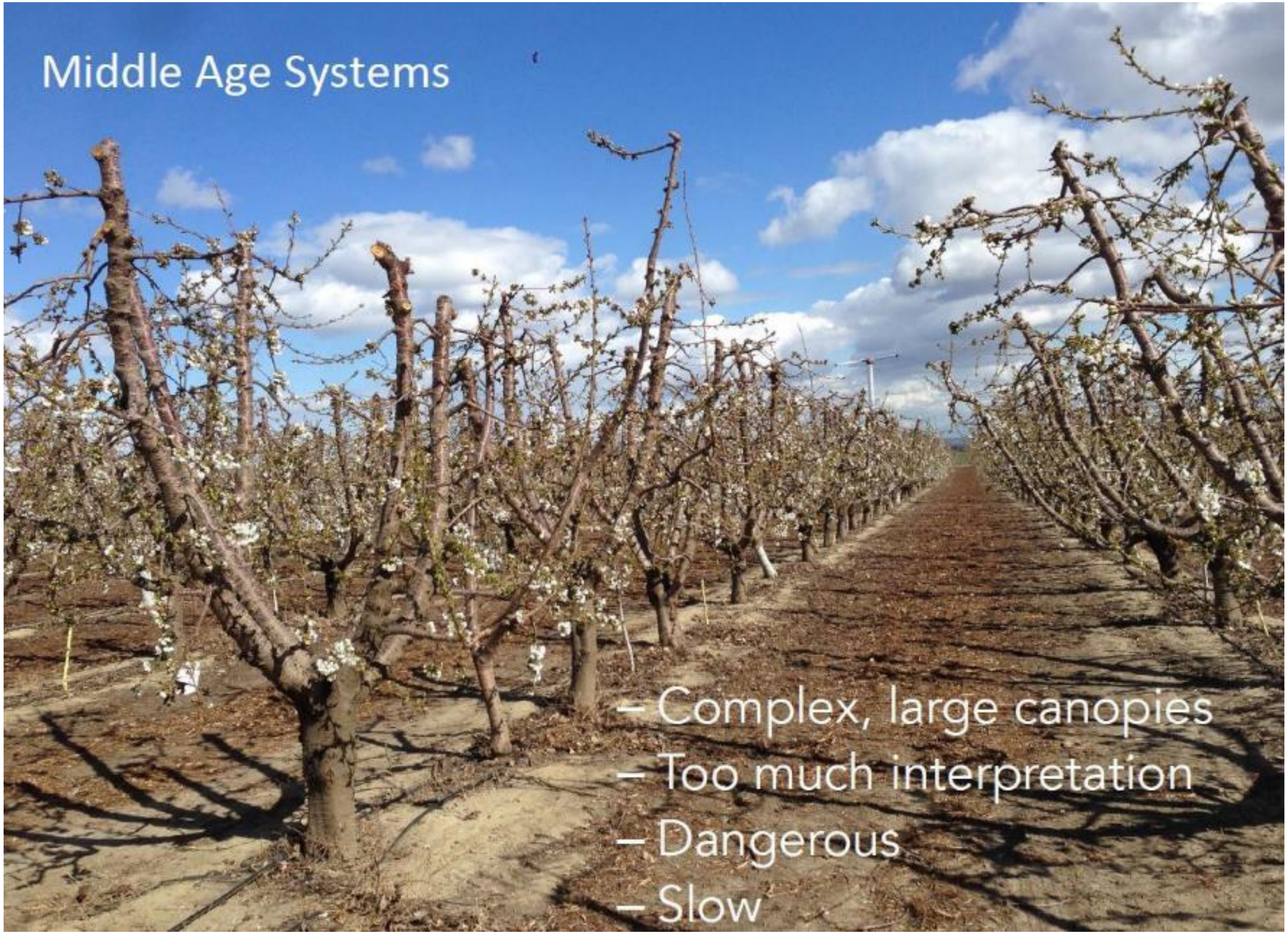
Washington State University

Large canopies are to complex:

- Slow to operate – control fruiting wood, nutrition etc.,
- Difficult to manage – pruning & training, harvesting, costs of pests & disease control
- Dangerous and costly

Washington State University

USA



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Washington State University

USA

Is this what we want ?

What production systems can deliver this result?

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Is the future cherry orchard this?

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- 2 dimensional fruiting walls
- Simple to manage
- Easy to manipulate through management practices
- Reduced management costs

- Increased set up costs

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Washington State University

Is the future cherry orchard this?

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Washington State University

Vertical UFO system (USA)

Y-Trellised UFO system (USA)

Key critical factor: PAR interception of vertical and angled fruiting walls

Benefits of fruiting walls:

Washington State University

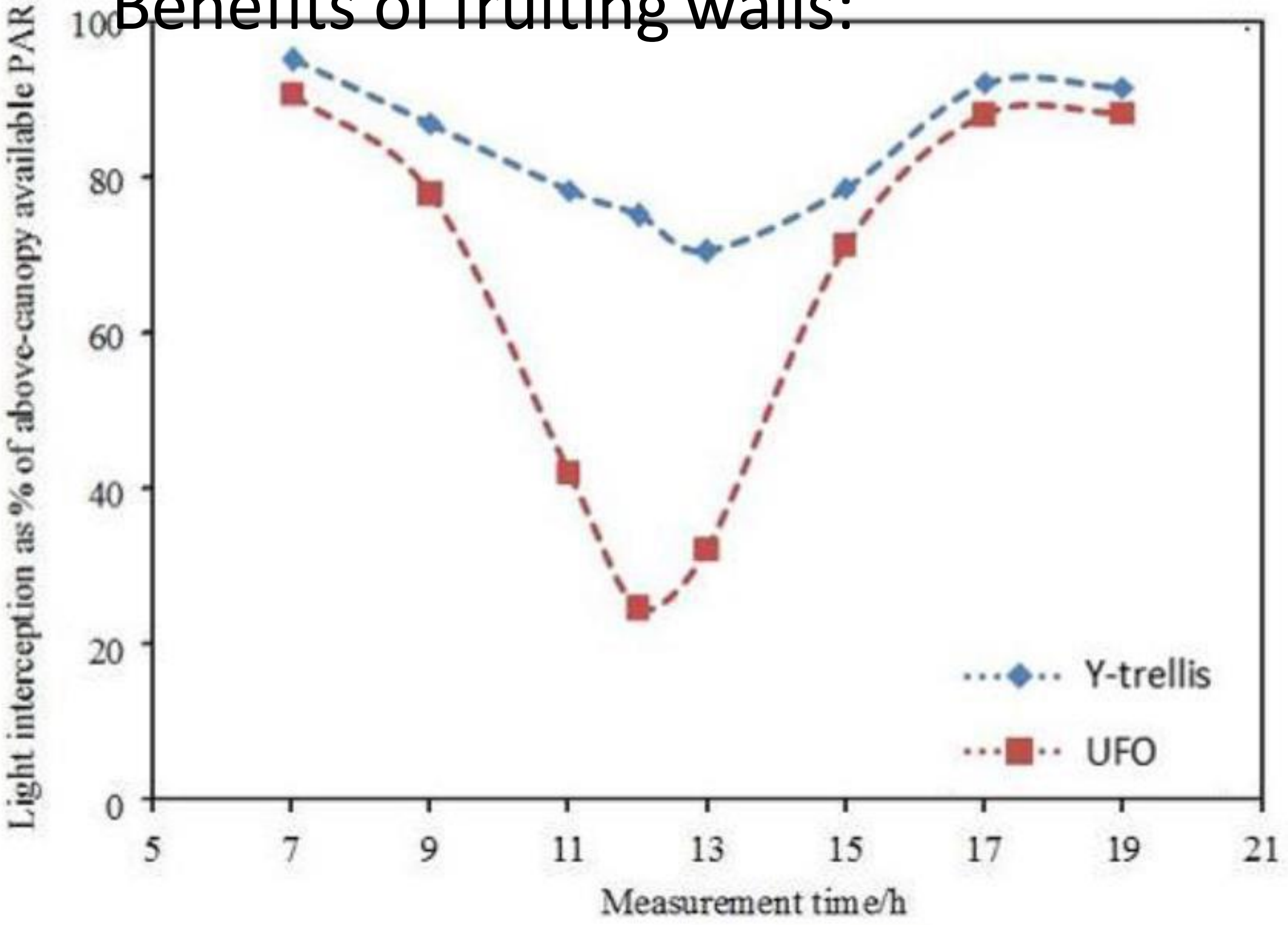
USA

PAR interception: vertical vs. angled fruiting walls

Diurnal trend

Yield potential on angled canopies is greater than planar canopies

5 year old ‘Santina/Giselar 12
35 tonnes / ha (Y-trellis UFO)



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Washington State University

Harvest efficiency

- Test in sweet cherries and apples
- Training systems have a substantial effect on harvesting efficiency and costs

USA

Cultivar		Training System	Mean Harvest Rate (kg/min)
Sweet Cherries	Bing/'Mazzard'	Traditional open center	***0.47 ± 0.12***
	Chelan/'Mazzard'	steep leader (4-5 upright leaders)	***0.53 ± 0.13*** *(+13%)*
	Tieton/'Gi5'	Central leader	***0.64 ± 0.19*** *(+36%)*
	Sweetheart/'Mazzard'	KGB	***0.72 ± 0.17*** *(+53%)*
	Cowiche	UFO	***0.81 ± 0.18*** *(+72%)*
Apple	Fuji (Apple)	moderate density (7 x 13) central leader	***3.58***
	Braeburn (Apple)	high density tall spindle	***5.61 (+60%)***

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Is the future cherry orchard this?

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Other crops, what is happening?

Australia

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- Capture 70% of available light

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Australia

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Mechanisation

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Australia

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What are the effects of these new systems?

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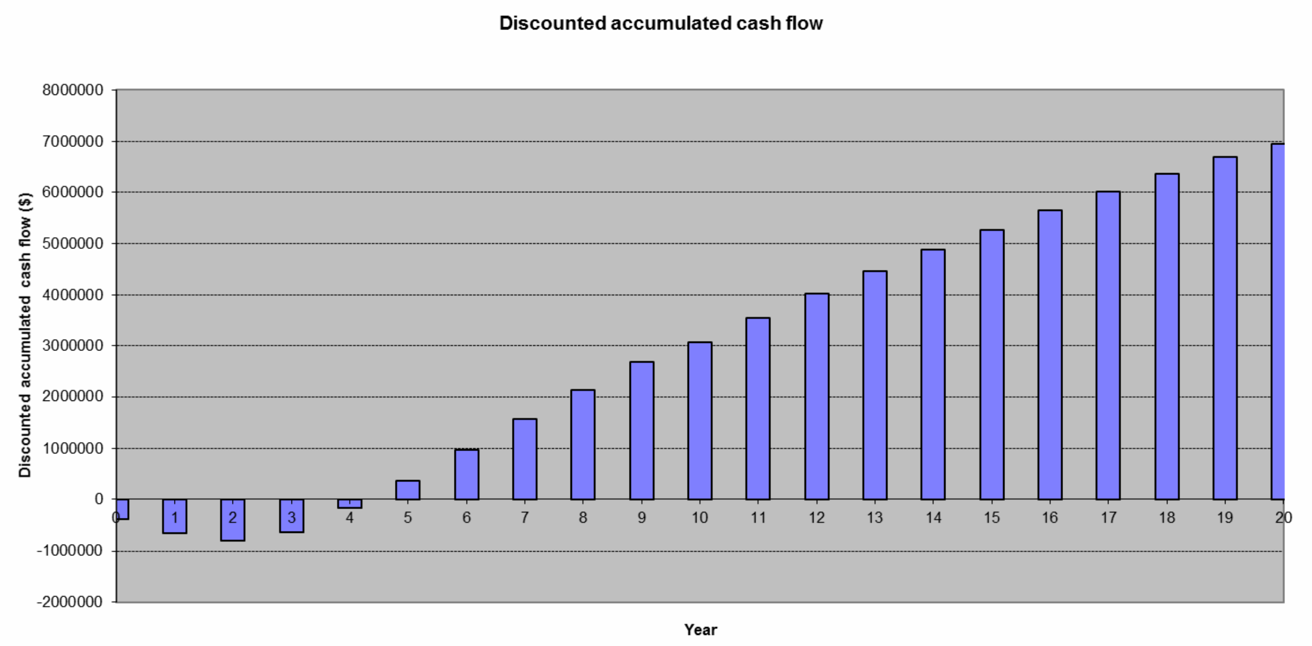
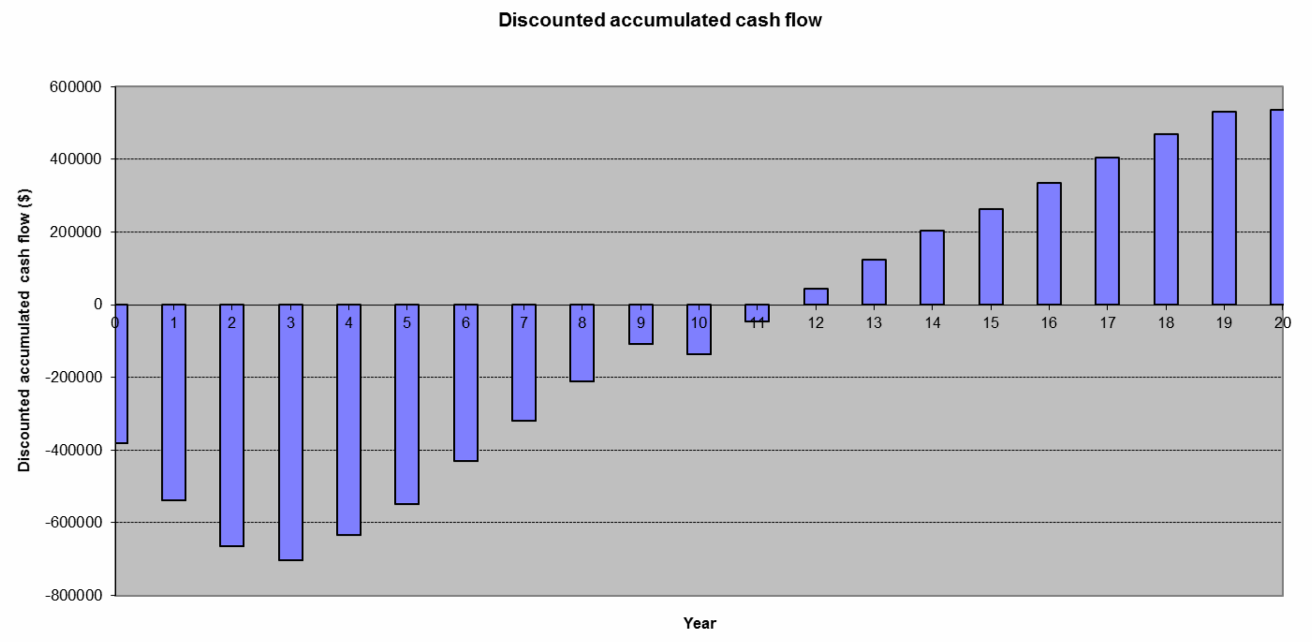
Double row V trellis system
Tree spacing
1.5 m between trees staggered double row
Row spacing 4 metres between rows
Trees 2286 trees/ha



Economics

Australia

Single row non- trellis system
Tree spacing
3 m between trees
Row spacing
4 m between rows
Trees 833 trees/ha



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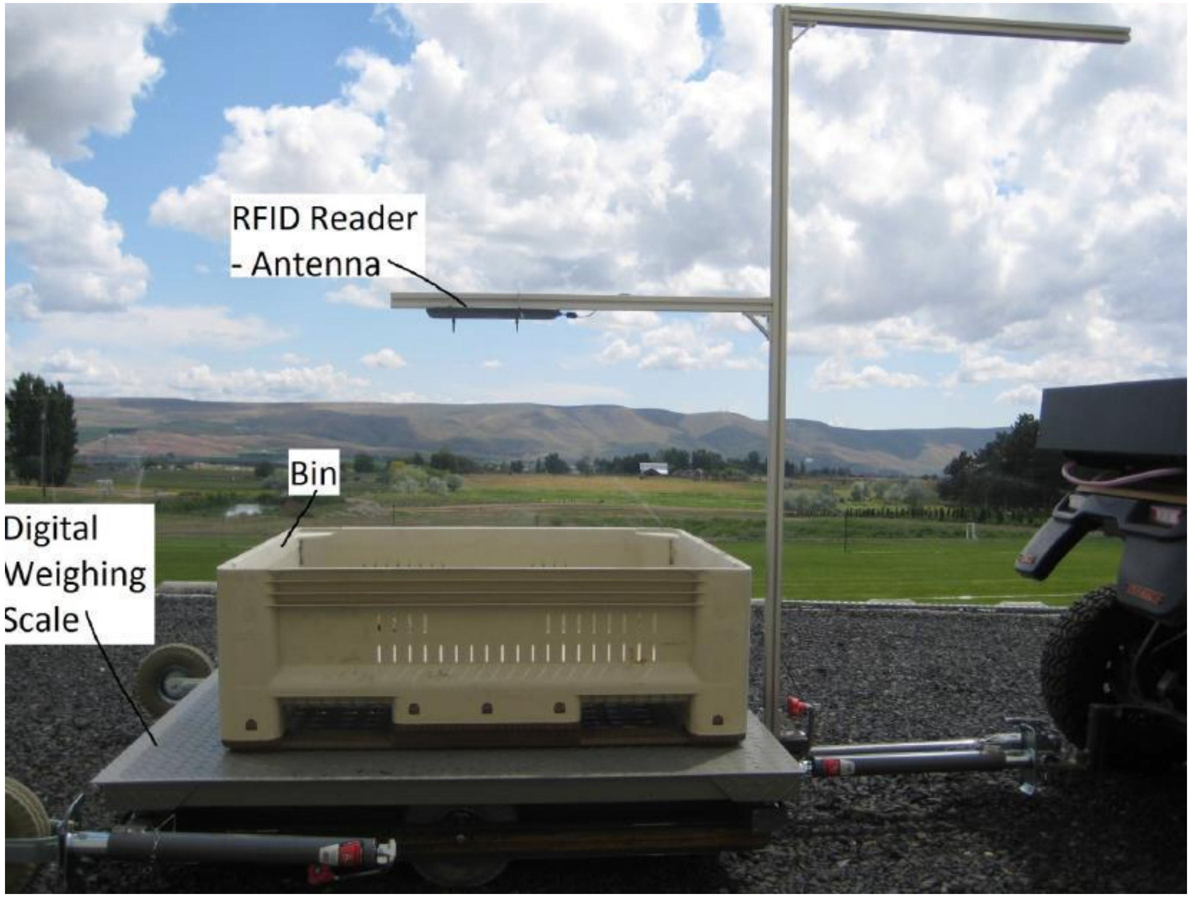
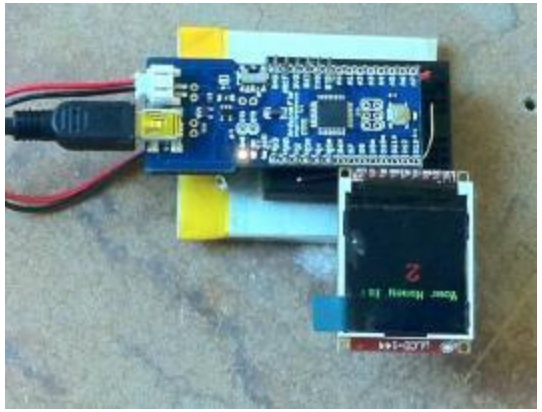
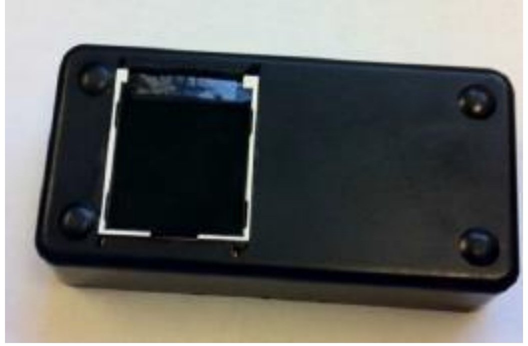
Labour efficiency

Precision Horticulture

Labour monitoring systems







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Washington State University

Mechanical harvest

- Taking short- and long-term look using total systems approach
  - Mechanical assist (shake-and-catch)
  - Fully mechanical harvest

Key components

- Improve labour efficiency & safety
- Mechanisation or assisted mechanisation

Washington State University

USA

- 3-4 fold improvement in harvest efficiency with shake-and-catch system
- Worked with 10 growers in 2013/2014 to test/demonstrate the system
- Sold stem-free and stem-on cherries (same price, package, orchard)

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Key components

- Are stem free cherries accepted by domestic and export markets?

USA

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Key components

- New packaging and marketing by Chelan Fresh

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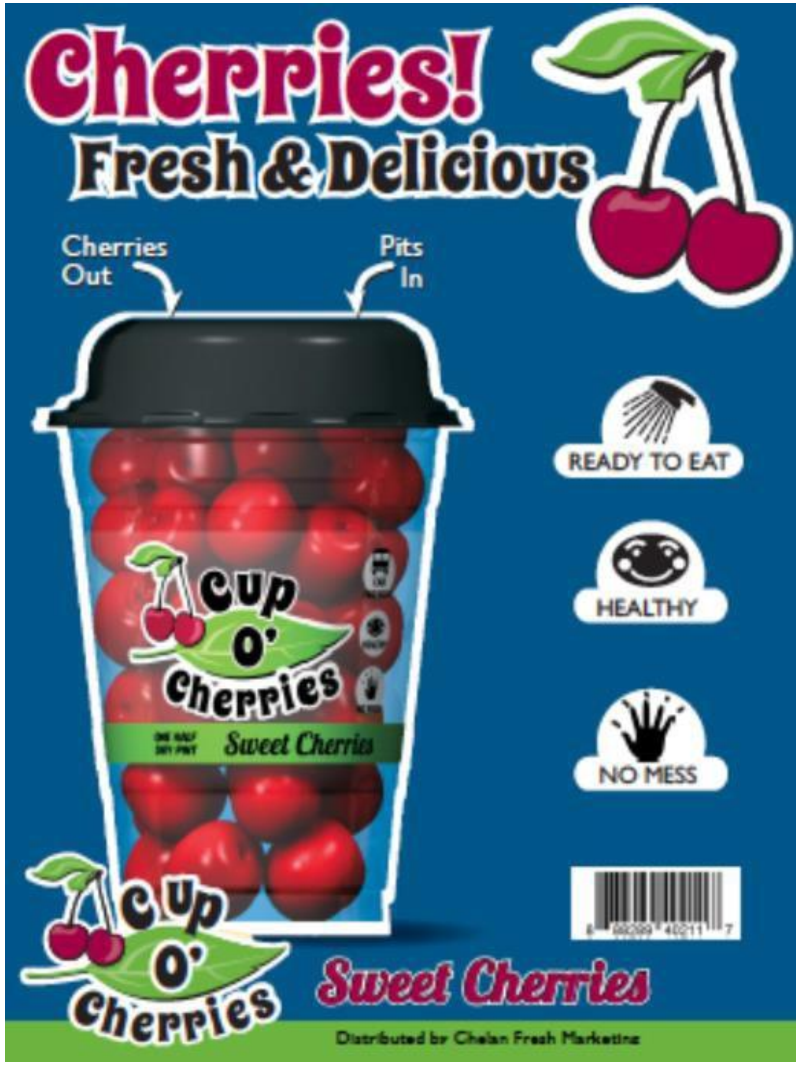
USA



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Key component

- Improve labour efficiency & safety
- Mechanisation or assisted mechanisation

USA

- Limb tying
- Thinning
- Pruning
- Harvesting

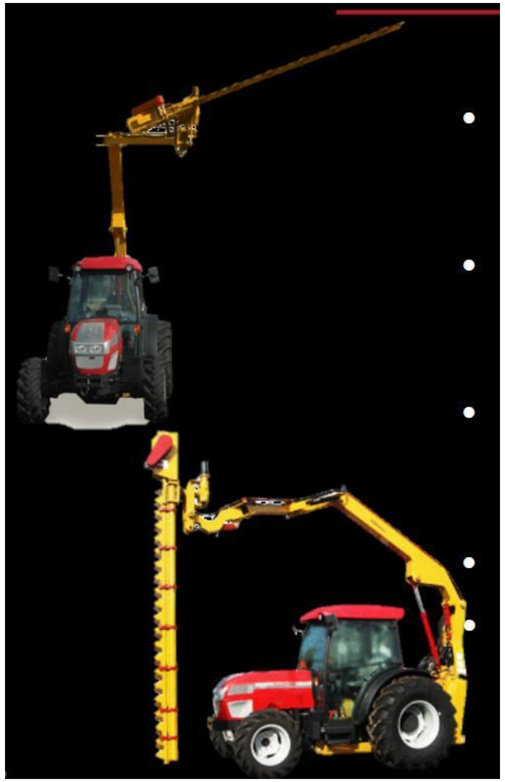
- Work at night

Key component

Washington State University

Determine best management practices for pruning sweet cherry and apple mechanically, by understanding equipment and orchard requirements.

USA



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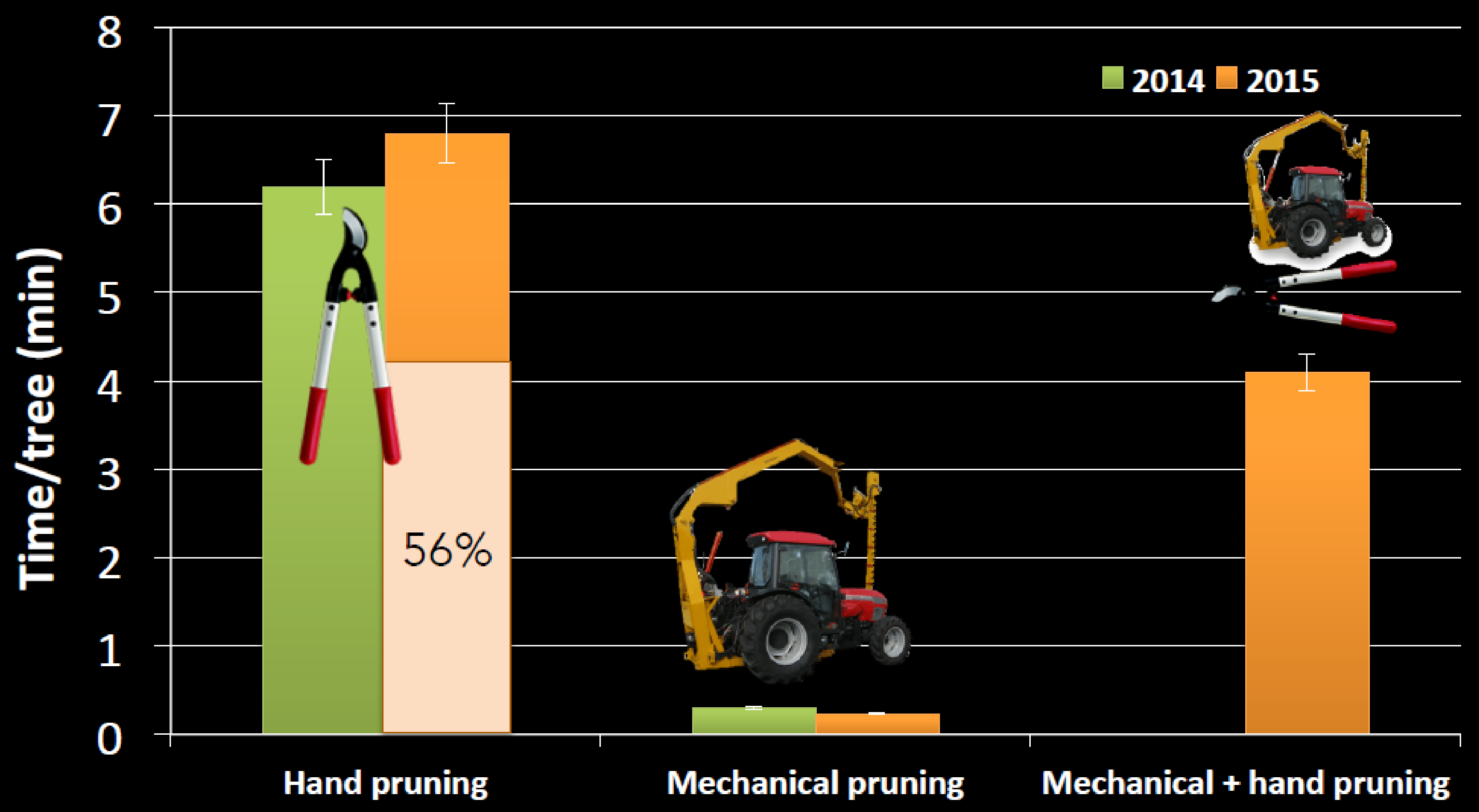
Washington State University

USA

Results: Time



Mech pruning 23 and 29 times faster than hand pruning (hedging and topping) in 2014 and 2015

Combination of manual and mech. pruning was twice as fast as hand pruning (ca. 2.0 km/h)

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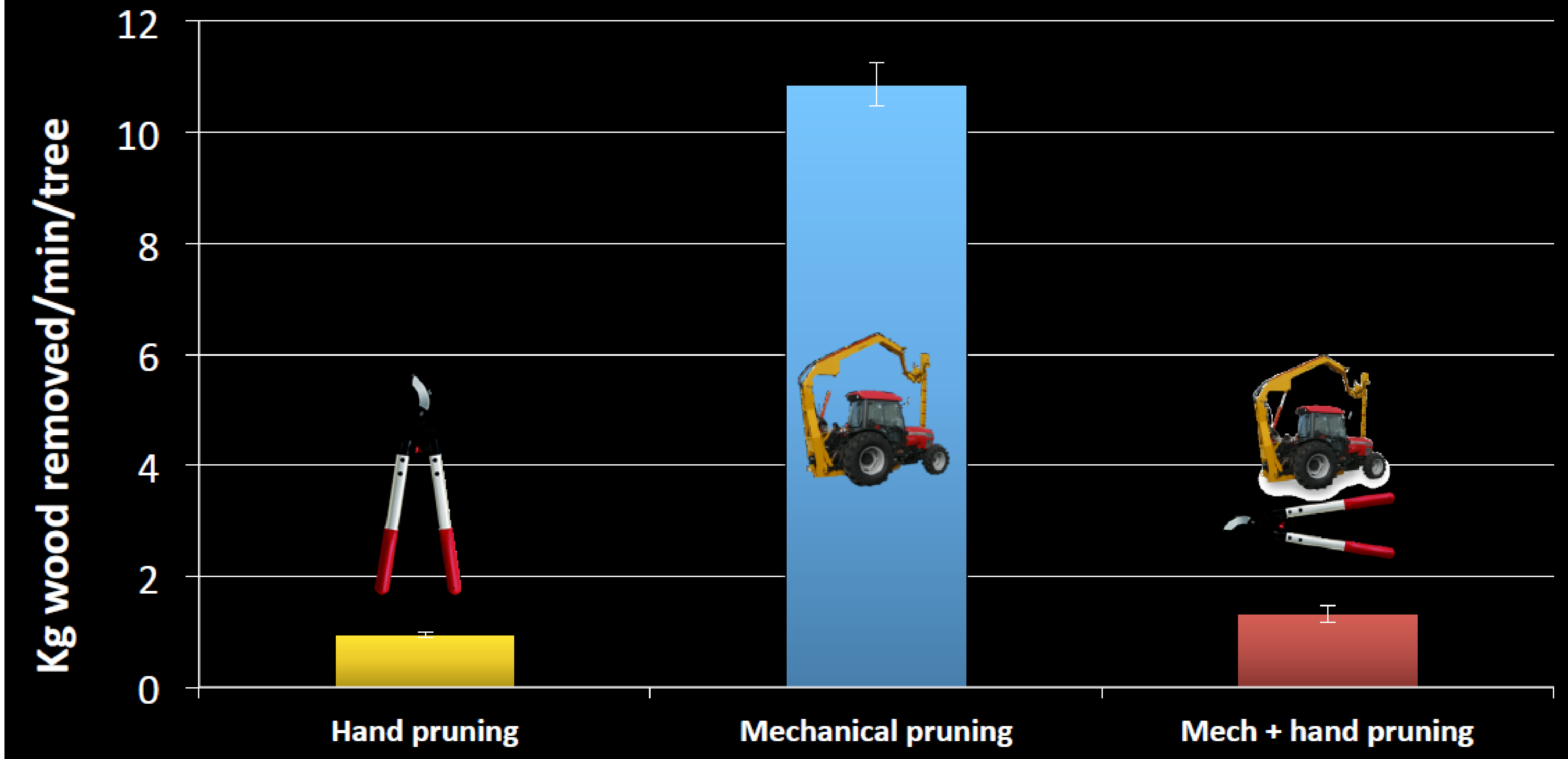
Washington State University

USA

Results: Efficiency 2015



Mech + hand pruning was 66% more efficient than hand pruning alone

Mech pruning was 11 times more efficient than hand pruning

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Pruning and Training Costs

Australia

- Palmette training systems (close planted) 1.75 m x 4 m (1428 trees/ha)
- Use of growth bio-regulators (split applications of 2 ml/tree 4ml/tree total)
- Mechanical pruning in spring & post-harvest topping & hand pruning in winter
- Peach cultivar - TropicBeauty 30% reduction in pruning costs
  - $2.39/tree or $2987/ha
- Nectarine cultivar – Sunwright 31% reduction in pruning costs
  - $2.54/tree or $3175/ha

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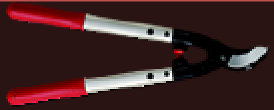
Washington State University

ASSUMPTIONS:
- 1 acre of UFO ‘Tieton’/’Gisela5’
- Full canopy
- 1350 trees/ha

1 person
8 hours work/day
$12/h
UFO pruning rules

USA

Estimated pruning costs	
	$741
	$168
	$590

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Washington State University

USA

Trial:

'Rainer'/'Giselar® 5'

Treatments
- Control (unpruned)
- Hand-pruned
- 20 days before harvest
- 10 days before harvest

Results:

- Mech-assist pruning was 7 times faster than hand
- Slight improvement (+12%) in colour with both timings
- Slight reduction (-9%) in soluble solids at 20 dbh
- Return bloom, regrowth TBD

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Future Cherry Orchards

Washington State University

USA & Australia

What is the future cherry orchard?

Totally new production systems in the foreseeable future (decision aid systems for growers)

- New orchard design
- New trellising systems
- New tree architecture
- New cultivars
- New rootstocks
- New canopy management systems (pruning & training)
- New plant bio-regulators (excessive vegetative growth = poor fruit quality & fruiting capacity)
- New nutritional and irrigation systems (mechanisation of delivery, control & monitoring)
- **Mechanisation or mechanical assistance** of labour intensive tasks (pruning & training, harvesting, post-harvest handling) – use of precision horticulture systems & electronics

Benefits: Reduction in the production system costs

Enhanced fruit quality; yield stability & predictability; profitability& sustainability

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Future Cherry Orchards

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Washington State University

Washington State University

What is the future cherry orchard?

USA & Australia

Horticulture Innovation Australia

Thank you Ladies and Gentleman

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Appendix M - Talks presented in WA by Dr Close and Mr Bob Nissen in Western Australia

NCDP 2016 Road Show events topics presented.

Presenters:

- Deputy Director of TIA, Associate Professor Dugald Close attended the road show event in Vic with the road show team of Associate Professor Matthew Whiting international guest speaker from Washington State University, consultant and cherry expert Mr Peter Morrison and TIA's NCDP coordinator Mr Robert (Bob) Nissen.
- Associate Professor Matthew Whiting, consultant Mr Peter Morrison and TIA's Mr Bob Nissen continued to each of the road show venues in NSW, and SA. Associate Professor Dugald Close returned to Tasmania due to other commitments.
- In NSW, Dr Penny Measham and Mr Dan Ryan joined the team for the road show events at Young and Orange.
- Associate Professor Dugald Close then joined the team for the last road show in Tasmania.

Road Show Topics:

International cherry expert and guest speaker Associate Professor Matthew Whiting provided the latest information on assisted pollination and the automation in future cherry orchards.

Assisted pollination: (Presentation Title: Floral Biology and Pollination Systems in Sweet Cherry)

Associate Professor Whiting indicated that it is well recognised in the literature that obtaining consistent yields for cherries every year is virtually impossible due to a large range of factors. Yield stability is a major industry issue in Australia and the USA. Floral studies undertaken in the USA revealed the stigma reaches maximum receptivity two days after flower opening. Unfavourable environmental conditions can have a significant impact on the stigma receptivity (stigmatic tissue and secretions) resulting in poor pollen germination and ovule fertilisation. New innovative assisted, automated pollination systems have been developed at Washington State University to achieve yield stability. Pollen collection, storage, pollen medium solutions and automated pollen application methods developed in the USA could easily be adapted to suit Australian conditions to enhance cherry pollination and reduce yield instability. However, floral studies on cultivars would need to be undertaken in Australia, to establish if cultivars and flowers exhibit a similar pattern to that seen in the USA.

Cherry orchards of the future: (Presentation Title: Tree Fruit Research at the Intersection of Biology and Technology)

In the second presentation by Associate Professor Whiting, growers were asked to think about what a future cherry orchard may look like in terms of:

- orchard design (trellised close planted tree vs non trellised trees widely spaced)
- light interception levels (vertical tree canopies vs sloping tree canopies and impacts on fruit quality and yield capacity)
- tree architecture (pedestrian free standing trees vs trellised fruiting walls)
- mechanically pruned vs hand pruned (reduction in labour costs and impacts on fruit quality)
- mechanically harvested vs hand harvested (use of platforms, automated picker and harvesting documentation, branch shaking and berry removal, impacts on fruit quality)
- acceptance by consumers of stem-less cherries

Growers all agreed that escalating labour costs in Australia and difficulties in finding suitable pickers are two of the factors affecting Australian cherry growers. The presentation by Associate Professor Whiting focused attention on what their cherry orchards may look like in the future, including tree architecture, automated pruning and harvesting. To remain economically viable growers will have to implement changes, and many growers agreed that they need to change.

Queensland fruit fly management in NSW:

Dr Penny Measham, from the HIA Queensland Fruit Fly (Qfly) Area Wide Management (AWM) coordinator and Mr Dan Ryan Program Director of Sterile Insect Technique (SIT) presented information on the developments within SIT and AWM. Controlling Qfly and market access, wide area management and release of male sterile Qfly were major issues expressed by NSW growers.

Grower discussions: Many growers in the Young and Orange Districts are trying to understand how a systems approach to management of Qfly would work in their respective regions. A systems approach, while all encompassing (undertaking field through to postharvest practices in an effort to control and limit potential Qfly infestations), appears to be some years off in these regions.

However, NSW DPI is conducting research on Qfly infestation periods. A large body of evidence is being collected indicating that Qfly did not breed or lay eggs until the southern NSW cherry harvests were completed. Further research into irradiation of cherry fruit is in progress and a pilot program sending irradiated fruit to Indonesia is in development.

The cherry producing farms are spread throughout the districts and are not aggregated in defined areas. This may limit the potential of wide area management strategies. However, growers in these regions can make substantial gains by understanding and implementing Qfly management strategies (monitoring, infield practices and sterile fly releases etc.) for their individual properties. Possibly the biggest gains will come from the implementation of postharvest disinfestation practices to obtain market access.

Field Walk Topics:

Consultant Mr Peter Morrison conducted the field walks at each location. Mr Morrison discussed the latest information on cherry spur leaf development, and advocated the use of zinc and nitrogen, which influence fruit size and quality, to increase leaf size. He also provided information on the use of Regalis® and Retain® at flowering to improve fruit set and retention. These topics were well received by growers and further topics discussed at all locations included cultivars, timing of flowering, pollinators, rootstocks and fruitlet retention. In South Australia further discussions were held on climatic impacts and development of benchmarking program for growers to assess and determine crop load levels.

Cherry fruit set –
what do we know and what can we do about it?

Dugald Close

Matt Whiting (and WSU team), Jo Jones, Sally Bound

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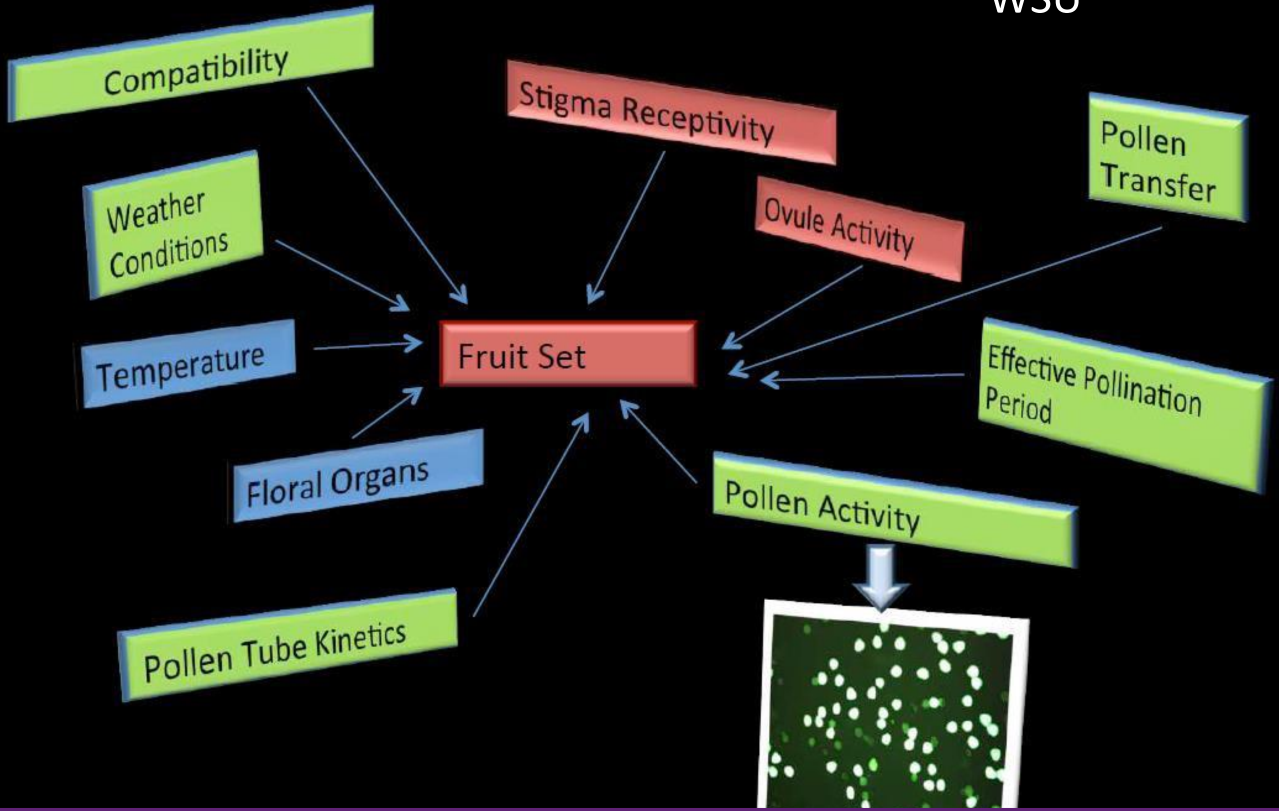
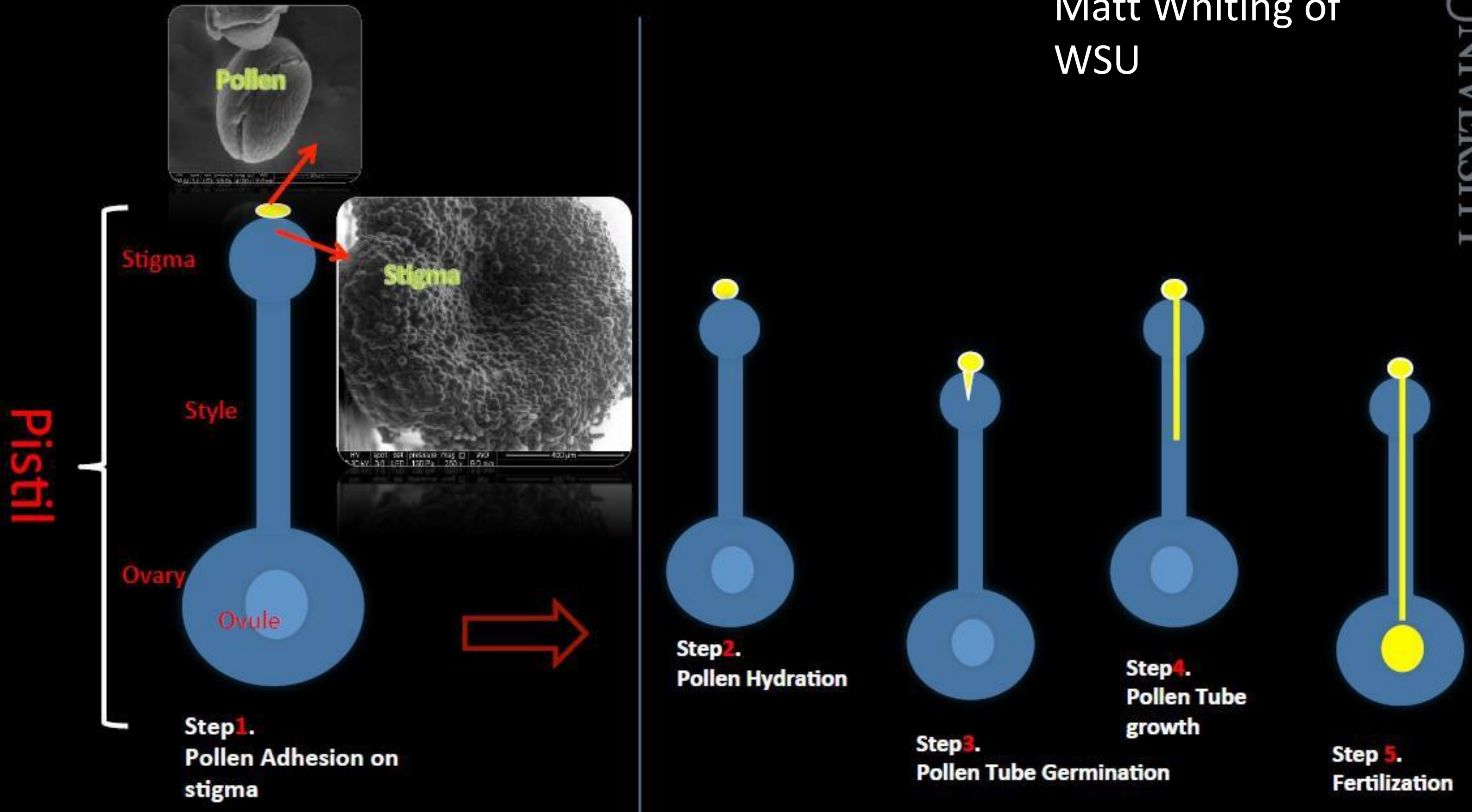
Factors Influence Fruit Set

Thanks to A/Prof Matt Whiting of WSU



Stigma Receptivity & Ovule Activity

Thanks to A/Prof Matt Whiting of WSU



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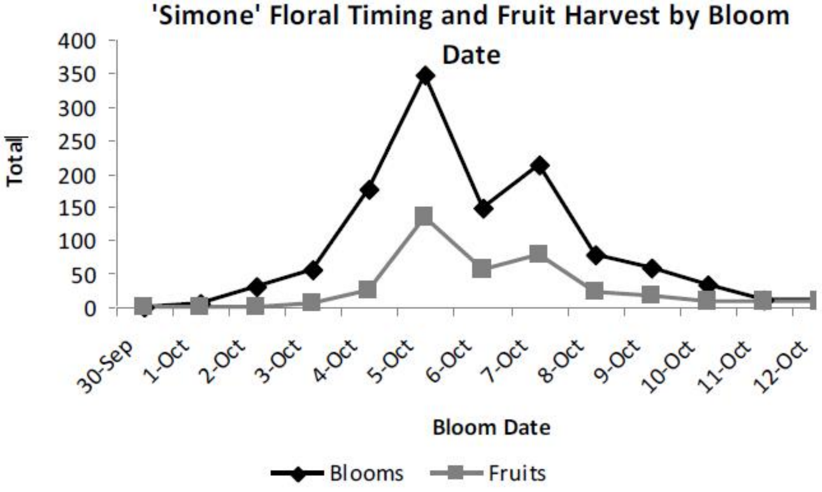
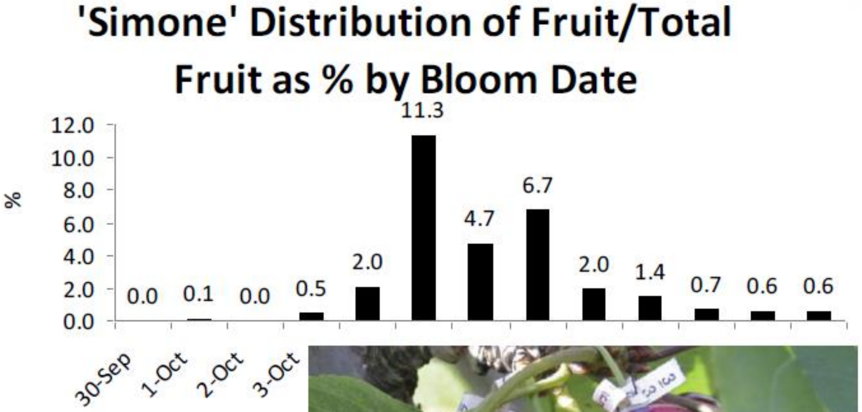
Pollen Compatability and Availability

Granger 1997, 2004

- Pollinisers reached full bloom (3-7days) before the other cultivars as pollen dispersal occurs after flowers open,
- Pollen needs to be available just as Kordia etc flowers open (when stigma most receptive)
- Majority of pollinisers were within 20m (but not necessarily closest 'pollinisers') of trees setting fruit
- Strong impact of mesoclimate on bloom dates eg. Crystal Creek 3-7 days behind Yark – winter chill and heat unit differences Pollen does not come in from outside bird netted areas

Flower timing – stigma receptivity and ovule longevity





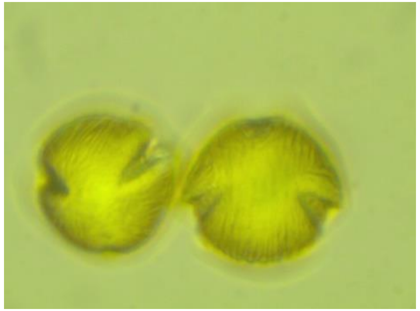
- Key points – 3-4 day window only!
- And similarity in timing between varieties (Van and Sweetheart) and sites

Floral biology project

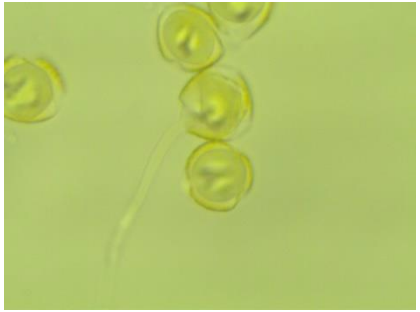
- 2014/15 season
- No CHO limitation impacting on shedding in Kordia or Regina prompted floral biology study
- *In vitro* investigations
  - Pollen viability
  - Pollen germination
  - Presence of pollen on stigma
  - Stigma receptivity

Results

- Pollen grains healthy
- In some orchards, bloom synchronisation between compatible pollinator cultivars was not ideal



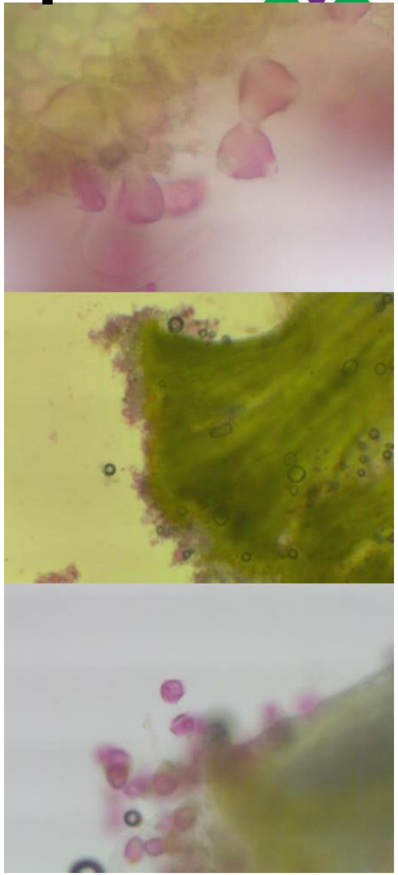
Kordia pollen grains



Sylvia pollen tubes

Rain negatively impacts pollen

- Pollen dispersal and germination appeared to be negatively impacted by rain events
- Possible that stigma receptivity also negatively impacted by rain events
- No published research on rain and pollen health or stigma receptivity



- In Midwestern US 2013 rainfall corresponded to fine pollen particles attributed to osmotic rupture of pollen grains (Rathnayake et al Atmospheric Chemistry and Physics 2017)

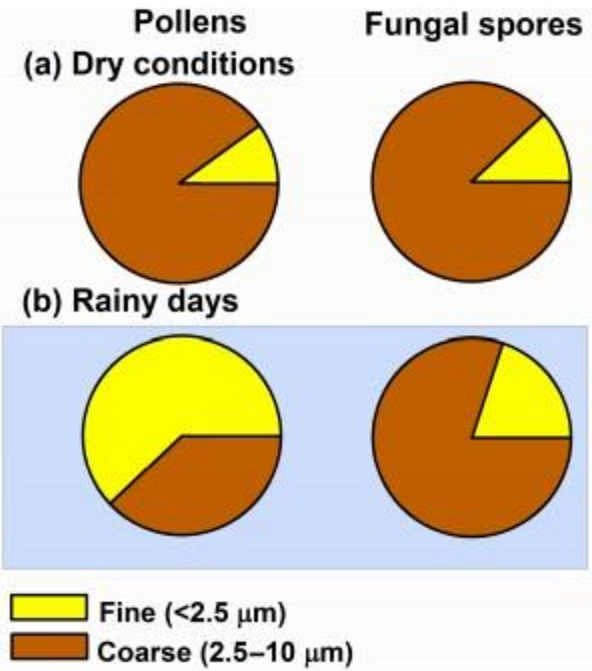


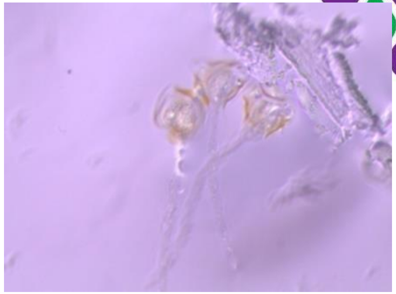
Figure 6. Distribution of pollen and fungal spore mass (apportioned by the CMB model) across fine and coarse PM during dry and rainy conditions. The fine- and coarse-mode distributions of pollens and fungal spores shifted towards fine particles during rain, with a more pronounced effect for pollens compared to fungal spores.

Temperature and light effects – note these data are for Pinot noir

	Outside	20-25° C glasshouse	30-35° C glasshouse	Shade house
Stigma Receptivity	No affect	No affect	No affect	No affect
Pollen Viability (%)	62	59	51	47
Pollen tube length (μm)	800	720	100	50
Fruit set (%)	84.8	67.8	48.3	41.7

Table 1: Stigma receptivity, pollen viability, pollen tube length and percent fruit set for potted Pinot Noir grapevines under varying environmental conditions.

- Lapins had high pollen germination percentages and very long tubes when grown in nutrient liquid agar
- Regina and Sylvia pollen tubes were long (top and centre images), except at one site which was impacted by rain events throughout bloom (bottom image)



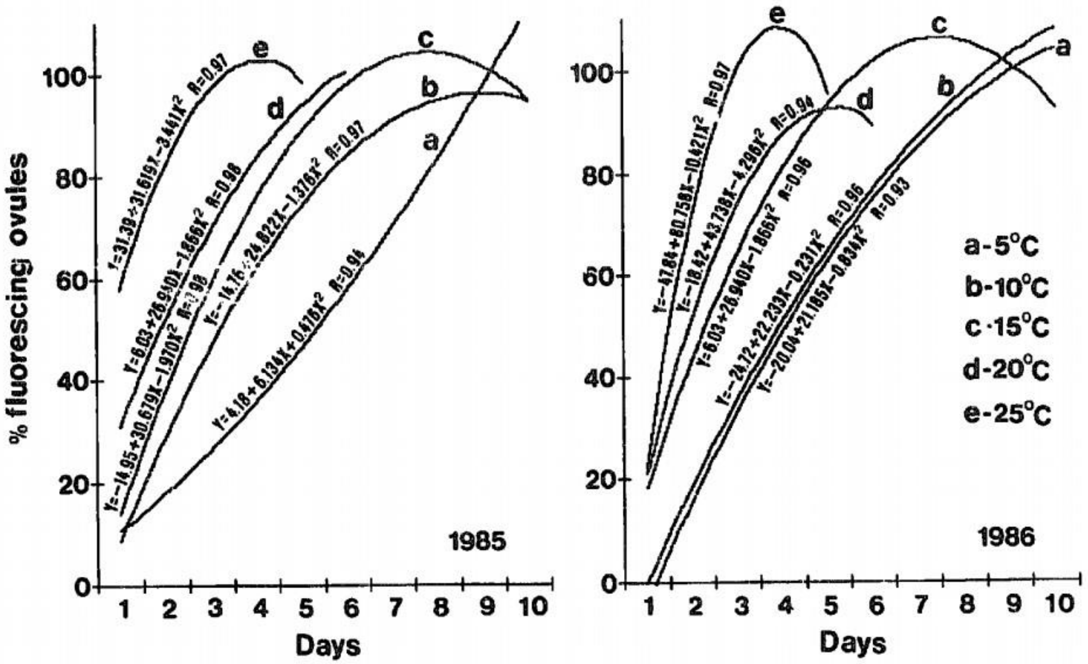
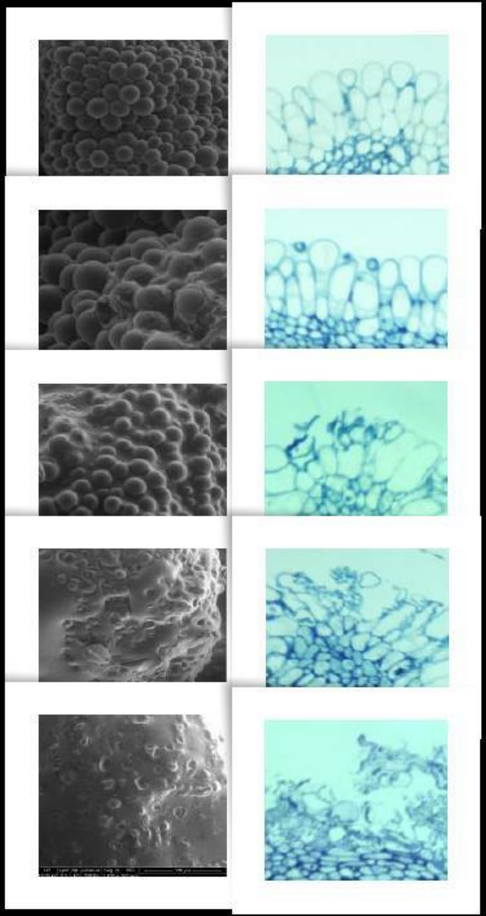


Fig. 1. Relationship between percent fluorescing ovules in 'Čačanski Rubin' and days after anthesis at different temperatures in 1985 (left) and 1986 (right). All *R* (multiple correlation coefficient) values are significant at $P<0.01$.

- Cerovic and Ruzic Sci Hort 1992

The Development of Stigma Surface



1 day

2 day

3 day

4 day

5 days

Days After Opening

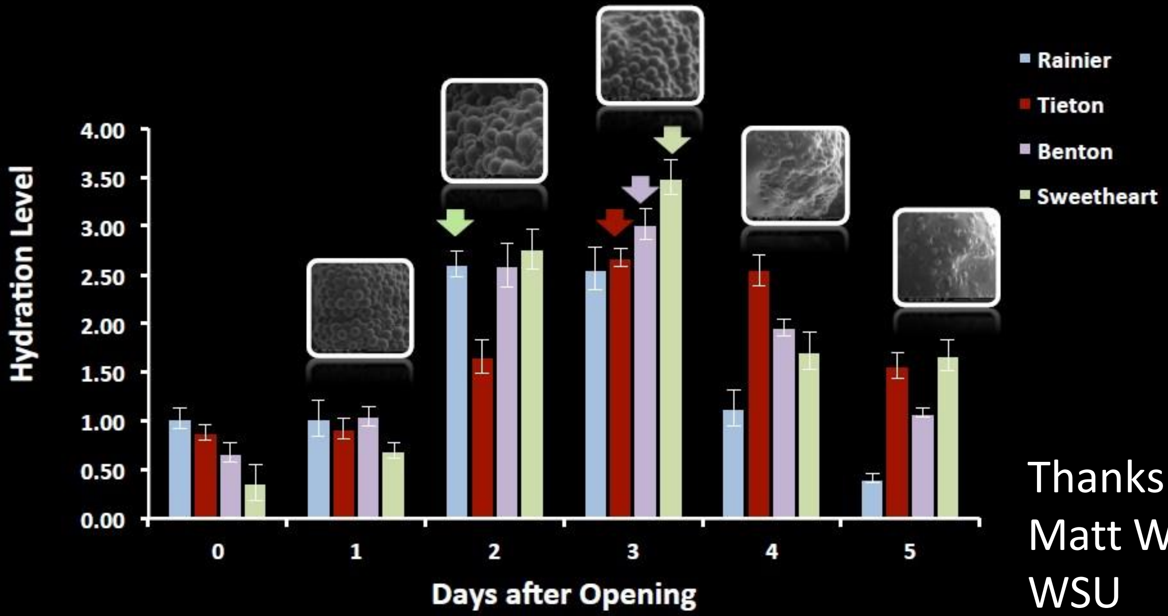
Thanks to A/Prof Matt Whiting of WSU

Results

No differences among genotypes

Pollen Hydration

- Flowers pollinated at 1-day intervals post-anthesis
- Pollen collected from stigma 20 mins post-pollination



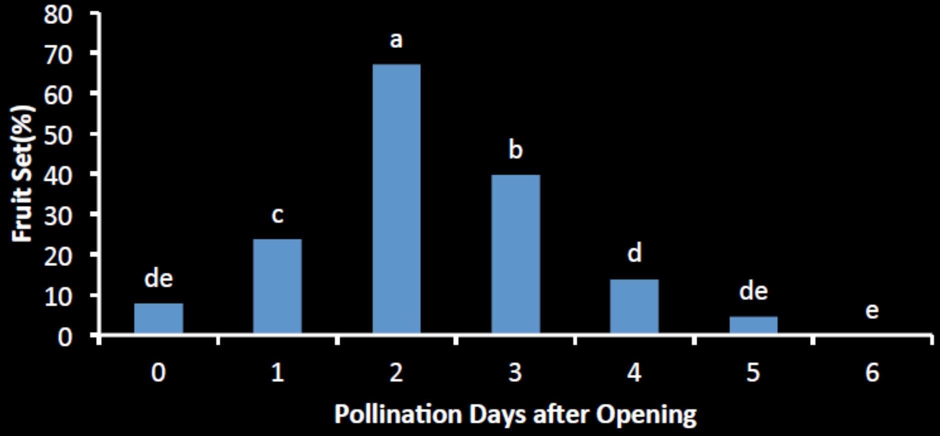
Thanks to A/Prof Matt Whiting of WSU

Results

No differences among genotypes

Fruit Set

- Hand pollinations in field at 1-day intervals
- Fruit set assessed at harvest



Thanks to A/Prof Matt Whiting of WSU

Results

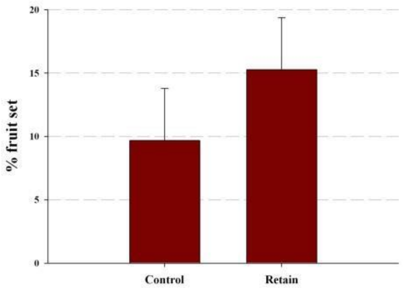
- Maximum fruit set when pollinated 2 days after anthesis

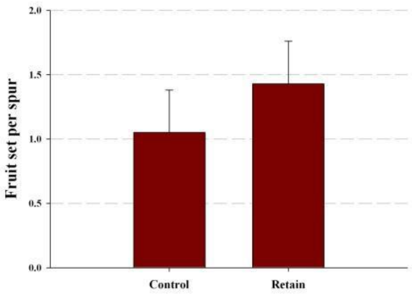
ReTain® (AVG) – anti-ethylene plant growth regulator

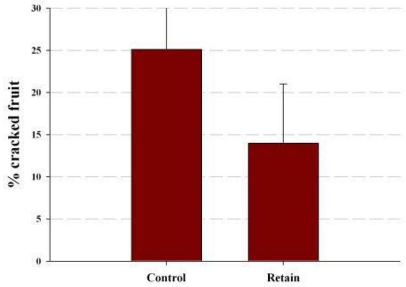
Fruit set – 2011/12

2011/12 season (Kordia):

Treatments:
1. untreated control
2. 4g Retain / 5L water @ 30% bloom (500g/ha)
3. 4g Retain / 5L water @ 80% bloom
4. 4g Retain / 5L water @ 30% & 80% bloom
5. 6g Retain / 5L water @ 30% bloom
6. 6g Retain / 5L water @ 80% bloom
7. 6g Retain / 5L water @ 30% & 80% bloom





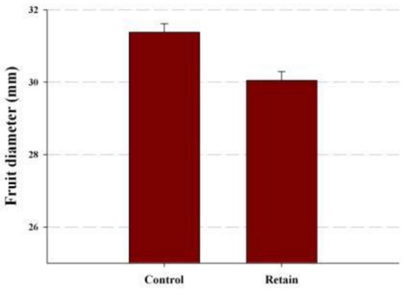


Higher fruit set, higher fruit set per spur (and less cracked fruit)!

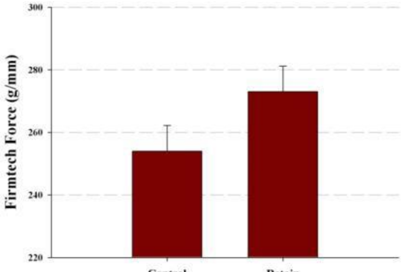
Fruit set

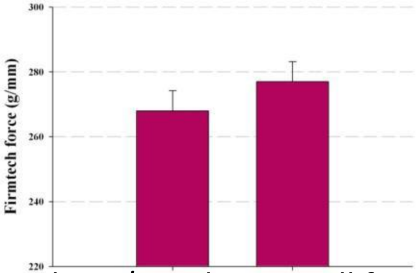
ii. Can we manipulate fruit set with PGRs?

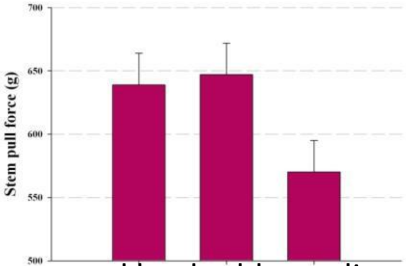
Yes but there are impacts on fruit quality associated with higher crop loads



- Higher set comes with smaller fruit



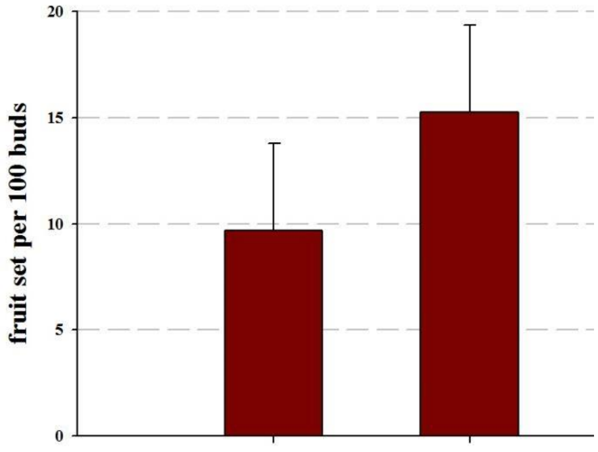




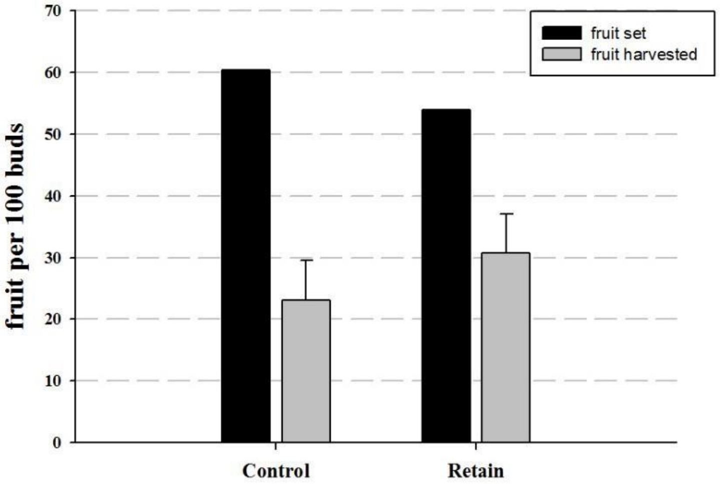
- Firmness greater with retain, with 6 g/L and stem pull force impacted by double application

Results: Fruit set 2012/13

Kordia - 3 weeks before harvest



Regina - 10 weeks before harvest



No significant differences for

- Retain rate, or
- time of application (30% bloom, 80% bloom or 30 & 80% bloom

Interim summary

- No variety differences in time that flowers are open, stigma receptivity or pollen hydration
- Limiting factor compatable pollen availability when stigma and ovules receptive?
- Rain impacts on pollen availability and viability and/or stigma receptivity
- Temperature impacts on ovule longevity
- Retain indicates important role of ethylene in less stigma receptivity / ovule longevity

Bees and pollination

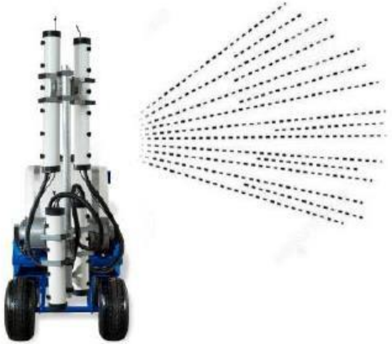
- Don’t like cool temperature, rain or wind
- Cost, availability, hive strength etc
- =RISK!!!

- (Bumble bees far more robust)

Pollen application

Spring 2014

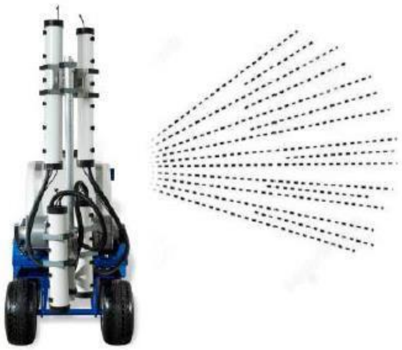
- Pollen
- Proprietary slurry



Viscous droplets

Spring 2015

- Pollen
- WSU-developed slurry

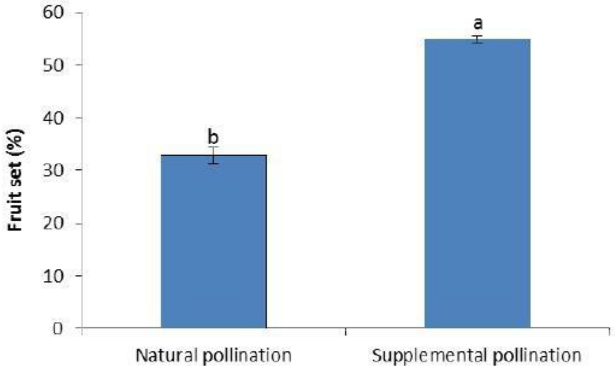


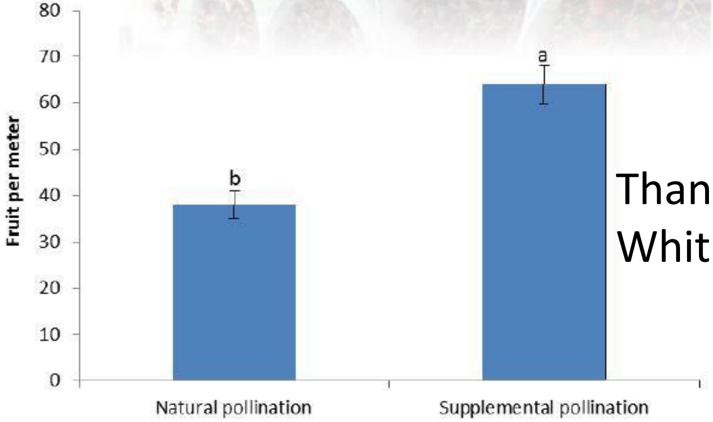
Non-viscous & fine droplets

Thanks to A/Prof Matt Whiting of WSU

Results: Spring 2015

Regina/Mazzard®

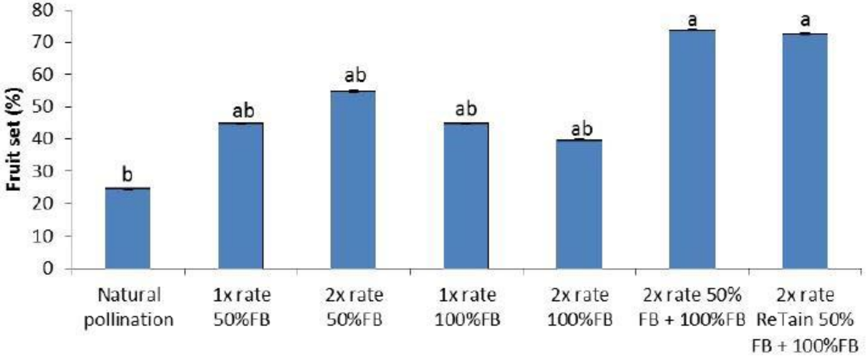


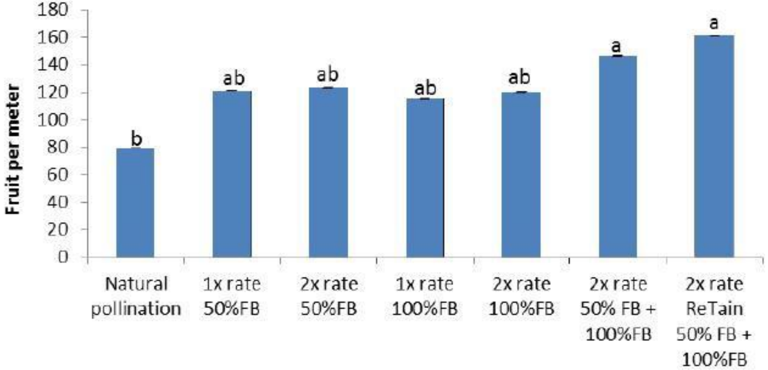


Thanks to A/Prof Matt Whiting of WSU

Results: Spring 2015

Early Robin/Gisela®12





Thanks to A/Prof Matt Whiting of WSU

Nutrition and ‘flower quality’

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- Different performance of flowers underidentical environmental conditions – related to crop load
- Ovule viability correlated with N and B concentrations in flower tissues
- Autumn B application - increases pollen tube growth

Conclusions

- Synchronisation of bloom time (i.e. 3-7 days before flowers open) of compatible cultivars is crucial
- Flowers are open and receptive for 4 days only
- Rain appears to have a negative impact on fertilisation. Bee activity, pollen dehiscence, pollen viability and stigma receptivity could all be involved.
- Temperature impacts: cool increases ovule longevity but decreases pollen tube growth and vice versa
- Temperature and light impacts on pollen tube growth of Pinot Noir
- Tree and flower B and N nutrition is important for flower health and pollen tube growth
- Matt Whiting's results indicate pollen availability is limiting in many rootstock/variety combinations – note dry, sunny growing environment
- Variability in fruit set = Rain? Temperature? On pollen and vectors? All factors depending on the site….
- (Precocious root stocks make fruit set impacts far less dramatic)

Management considerations

- Pollen compatibility and availability: understanding flowering timing and growing systems that provide compatable pollen at the right time – use of dormex? Graft in pollinators?
- Use precocious rootstocks in new blocks – modern training systems?
- Pollen viability: do rain shelters prevent pollen explosion?!
- Pollination: healthy and abundant (3 per ha or 6+ per ha?) hives within netted areas
- Tree nutrition postharvest for adequate B and N

Acknowledgements

- Thank you to Howard Hansen, Wayne Trengrove, Steve Chapman, Simon Rouget and Peter Morrison for discussions
- Optimising fruit set, crop load and fruit nutrition and size (Phase 1&2), CY10002 (flower timing, retain), CY12003 (floral biology) and the National Cherry development Program CY12023 (Matt Whiting presentation) projects were funded by Horticulture Innovation Australia Limited using the cherry levy with co-investment from TIA, Washington State University and funds from the Australian Government.

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Washington State University

Cherry Innovations®

Cherry Road Show 2017

By R.J. Nissen & Matt Whiting

Horticulture Innovation Australia

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Future Cherry Orchards

Washington State University

Key Production Trends ?

Yield

Quality

Costs

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To remain competitive the cherry industry must improve efficiency

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Future cherry orchards

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- Economically Profitable
- Environmentally sustainable
- Right cultivars
- Planted in the right location
- Grown with the right management/cultural practices
- Targeted at specific markets
- Stable yields & balanced production
- Produce high quality fruit, marketability & storability
- Efficient and effective production & marketing systems

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USA

Washington State University

USA

Is this the orchard of the future?

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Key components of future cherry orchards

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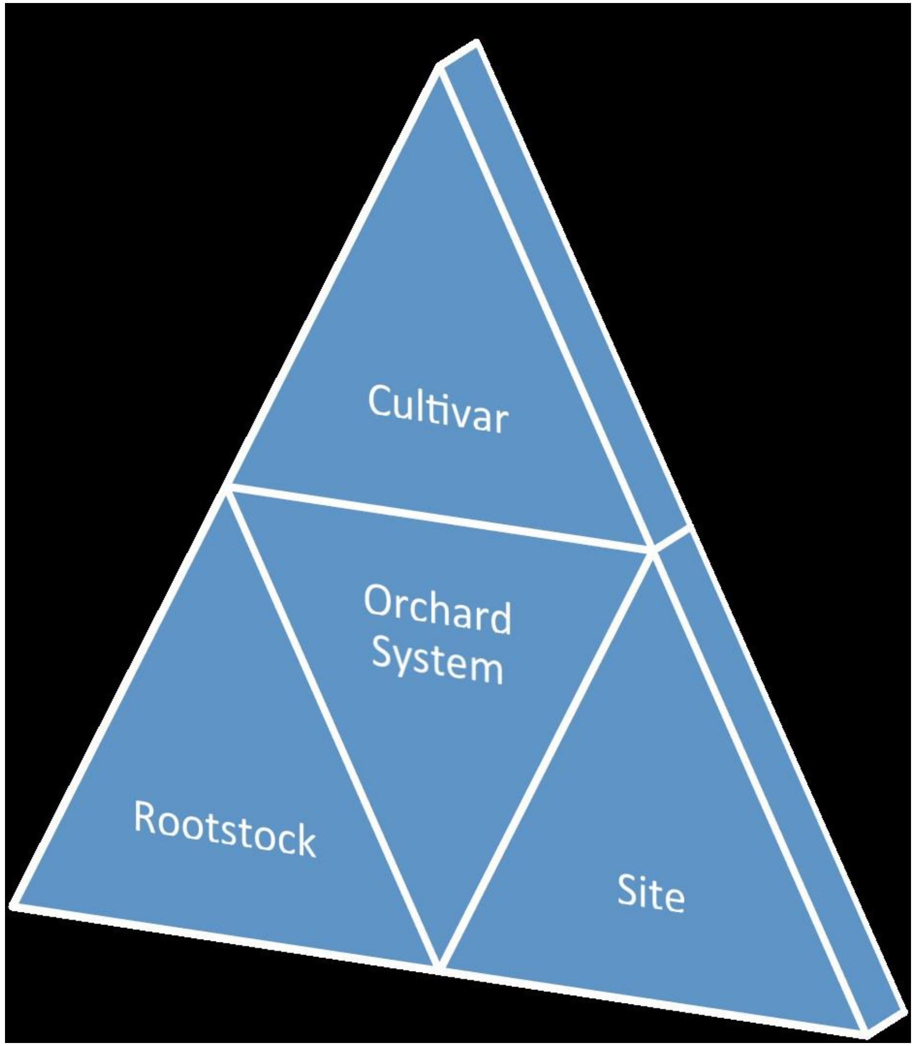
- Profitable & sustainable
- Precious & constantly productive
- Simple to manage
- Pruning & training - simple, efficient productive canopies



Ability to utilize automation & mechanisation (drive costs down)

Output vs. Input

Washington
State
University

Production Systems ?

Where do you want to be?

High

Output

Low

Low

Input

High

Washington State University

Large canopies are to complex:

- Slow to operate – control fruiting wood, nutrition etc.,
- Difficult to manage – pruning & training, harvesting, costs of pests & disease control
- Dangerous and costly

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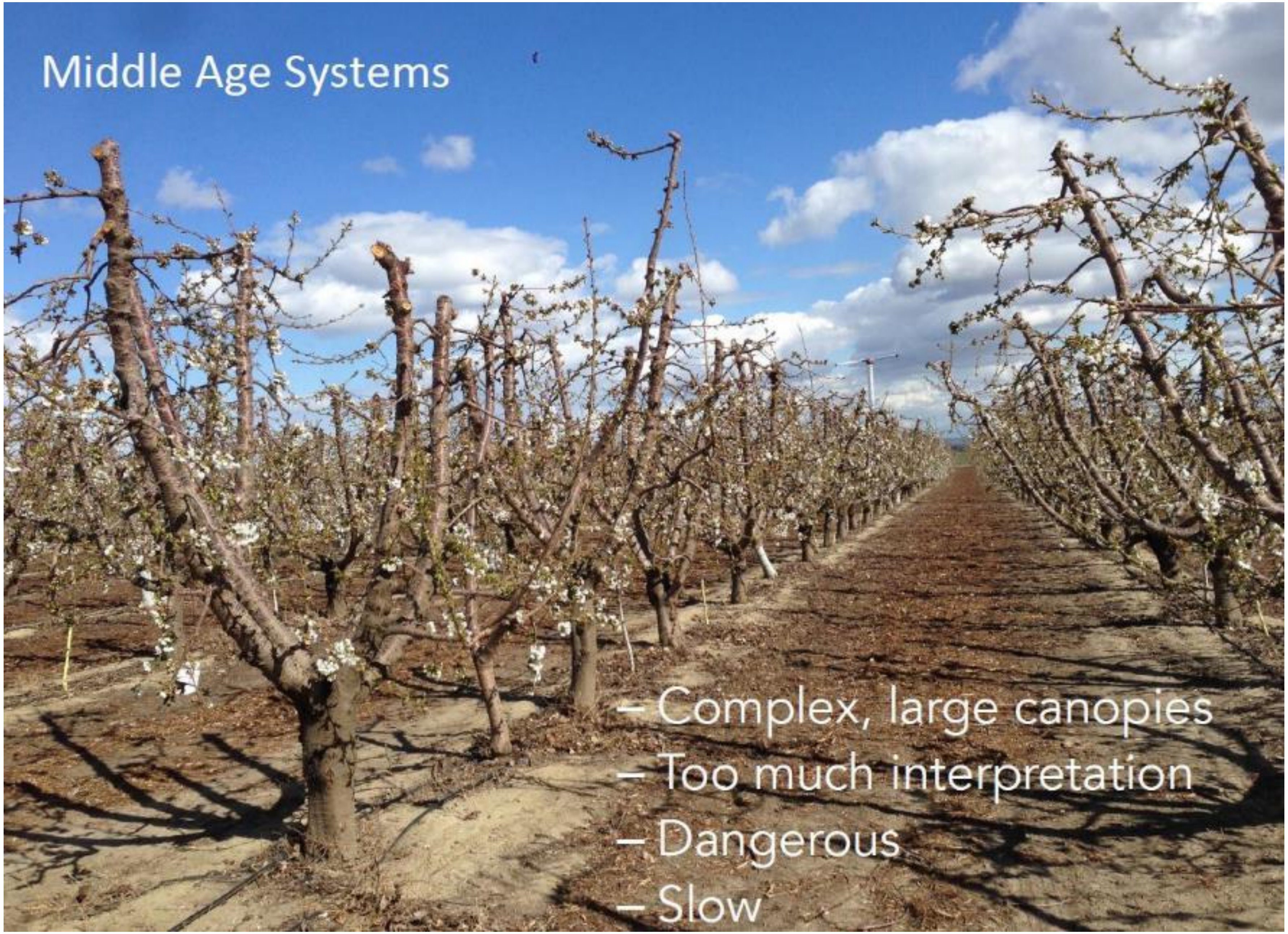
USA



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Is this what we want?

What production systems can

deliver this
result?

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Is the future cherry orchard this?

- 2 dimensional fruiting walls
- Simple to manage
- Easy to manipulate through management practices
- Reduced management costs

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- Increased set up costs

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Is the future cherry orchard this?

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Y-Trellised UFO system (USA)

Vertical UFO system (USA)

Key critical factor: PAR interception of vertical and

angled fruiting walls

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Benefits of fruiting walls:

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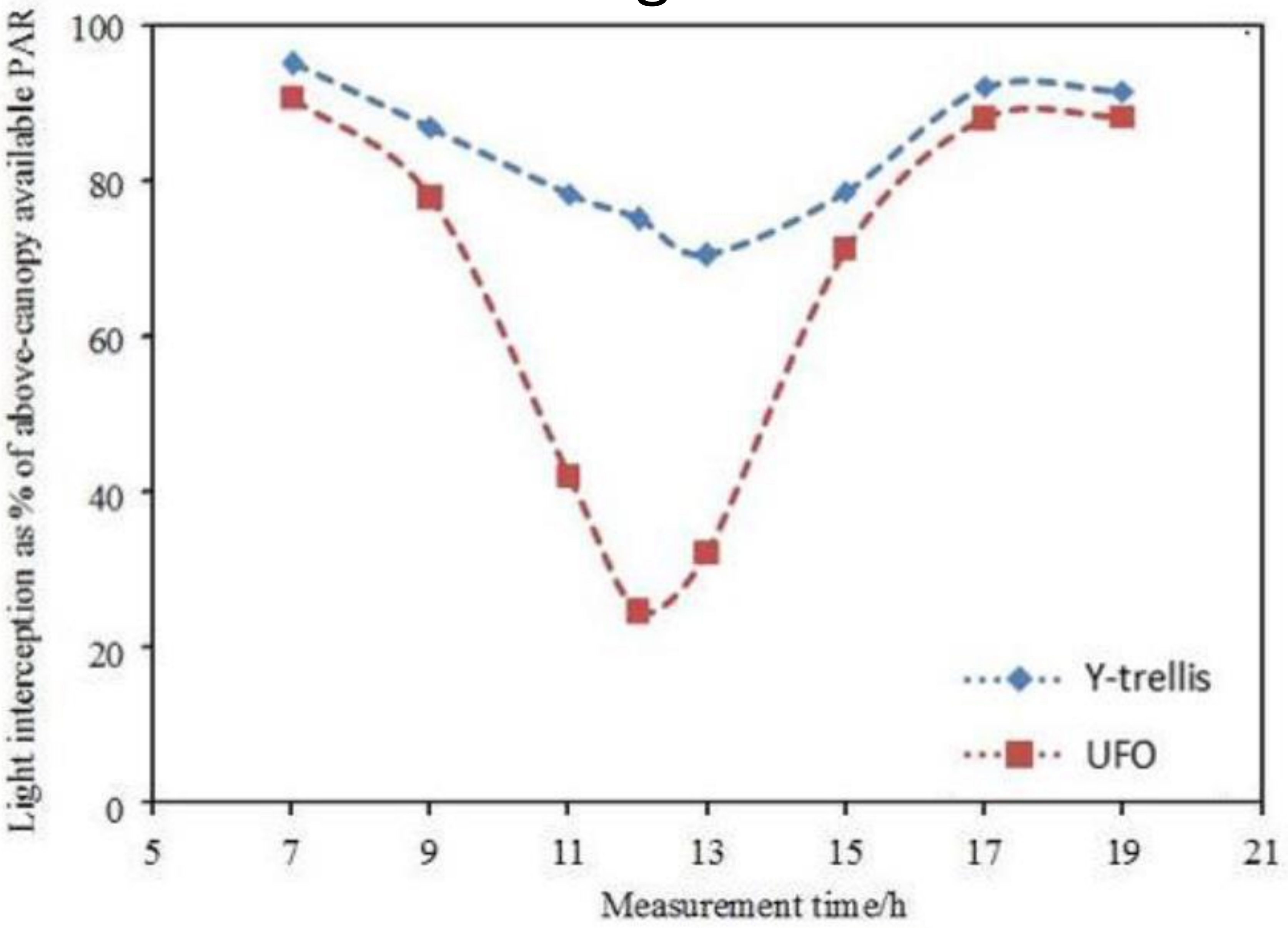
PAR interception: vertical vs. angled fruiting walls

Diurnal trend

Yield potential on angled canopies is greater than planar canopies

5 year old 'Santina/Giselar 12
35 tonnes / ha (Y-trellis UFO)



Harvest efficiency

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- Test in sweet cherries and apples
- Training systems have a substantial effect on harvesting efficiency and costs

USA

Cultivar		Training System	Mean Harvest Rate (kg/min)
Sweet Cherries	Bing/'Mazzard'	Traditional open center	***0.47 ± 0.12***
	Chelan/'Mazzard'	steep leader (4-5 upright leaders)	***0.53 ± 0.13*** *(+13%)*
	Tieton/'Gi5'	Central leader	***0.64 ± 0.19*** *(+36%)*
	Sweetheart/'Mazzard'	KGB	***0.72 ± 0.17*** *(+53%)*
	Cowiche	UFO	***0.81 ± 0.18*** *(+72%)*
Apple	Fuji (Apple)	moderate density (7 x 13) central leader	***3.58***
	Braeburn (Apple)	high density tall spindle	***5.61 (+60%)***

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Is the future cherry orchard this?

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Other crops, what is happening?

Australia

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- Capture 70% of available light

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Mechanisation

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What are the effects of these new systems?

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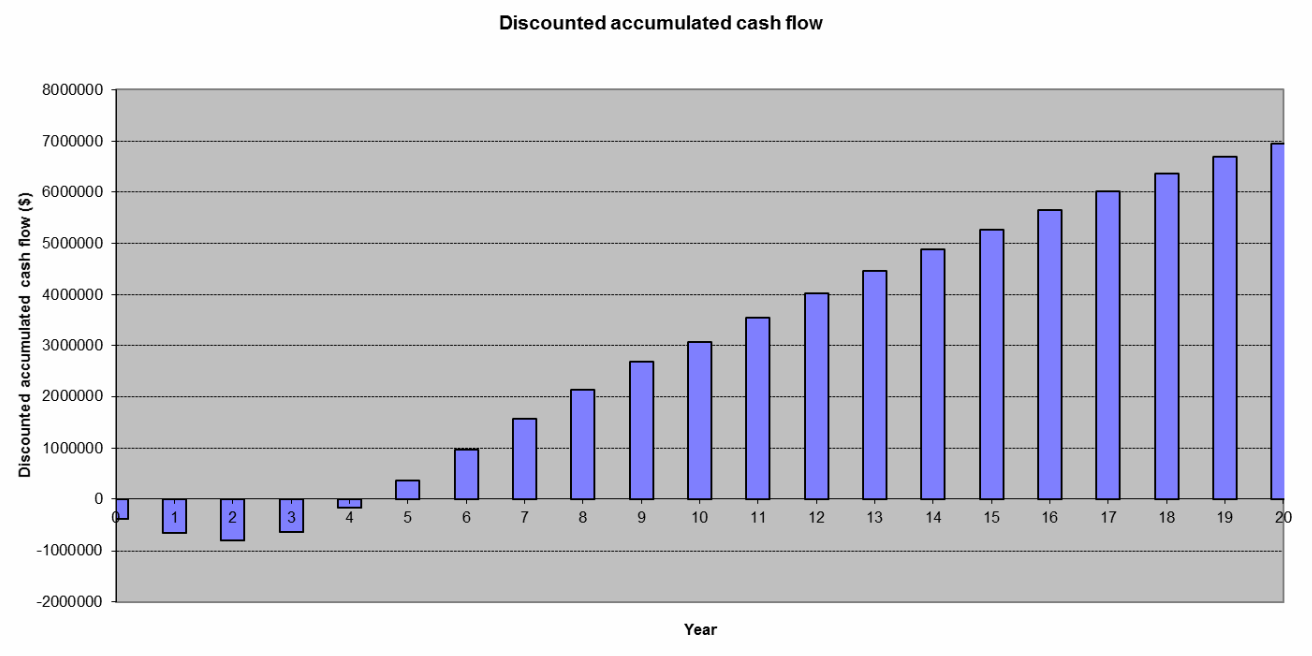
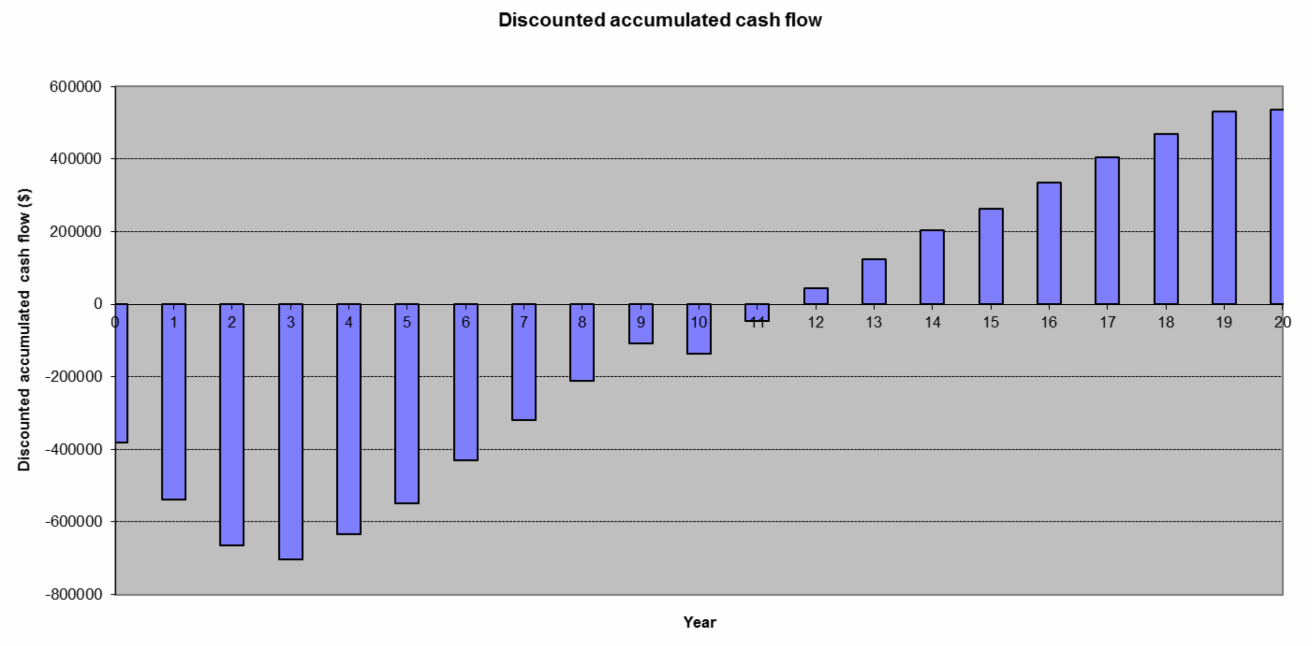
Double row V trellis system
<u>Tree spacing</u>
1.5 m between trees staggered double row
<u>Row spacing 4</u> metres between rows
Trees 2286 trees/ha



Economics

Australia

Single row non- trellis system
<u>Tree spacing</u>
3 m between trees
<u>Row spacing</u>
4 m between rows
Trees 833 trees/ha



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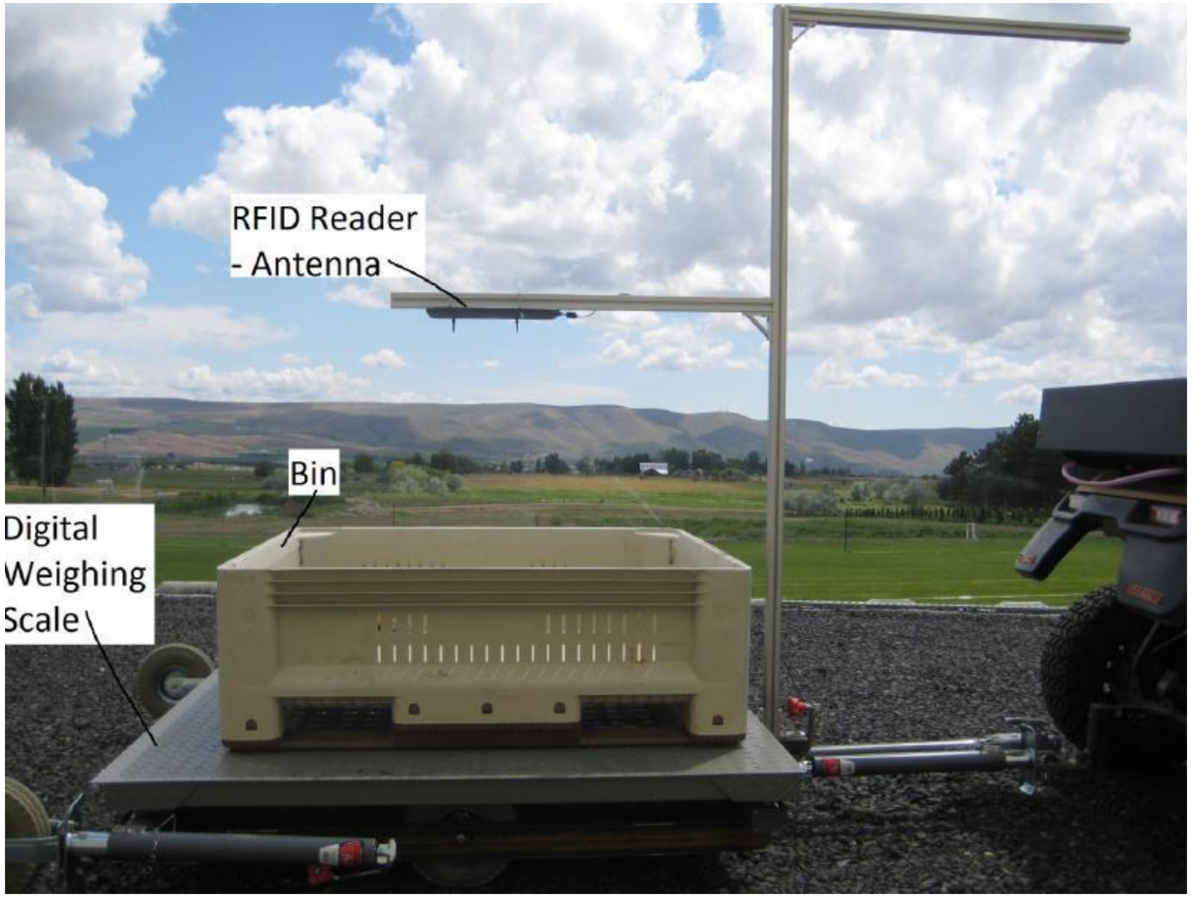
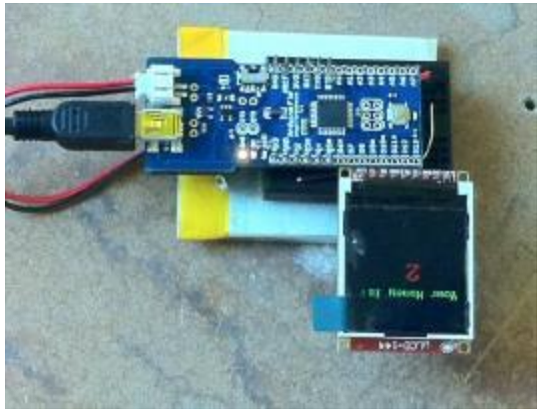
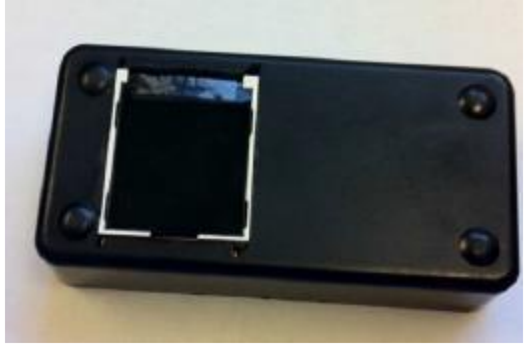
Labour efficiency

Precision Horticulture

Labour monitoring systems







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Mechanical harvest

- Taking short- and long-term look using total systems approach
  - Mechanical assist (shake-and-catch)
  - Fully mechanical harvest

Key components

Washington State University

- Improve labour efficiency & safety
- Mechanisation or assisted mechanisation

USA

- 3-4 fold improvement in harvest efficiency with shake-and-catch system
- Worked with 10 growers in 2013/2014 to test/demonstrate the system
- Sold stem-free and stem-on cherries (same price,

package, orchard)

Key components

- Are stem free cherries accepted by domestic and export markets?

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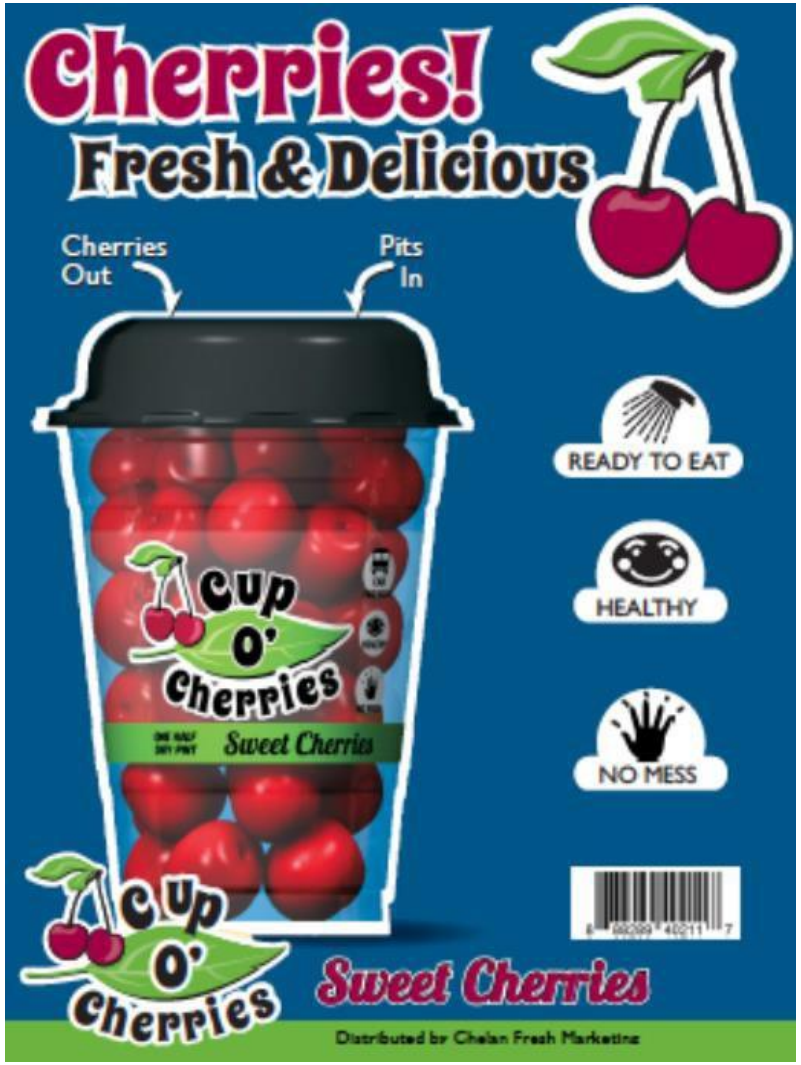
USA

Washington State University

Key components

- New packaging and marketing by Chelan Fresh



USA

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Key component

- Improve labour efficiency & safety
- Mechanisation or assisted mechanisation

USA

- Limb tying
- Thinning
- Pruning
- Harvesting

- Work at night

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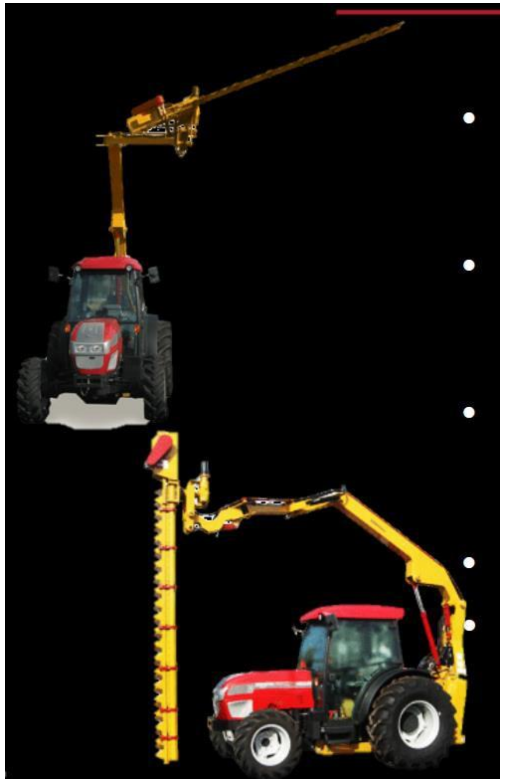
Key component

Determine best management practices for pruning sweet cherry and apple mechanically, by understanding equipment and orchard requirements.

USA



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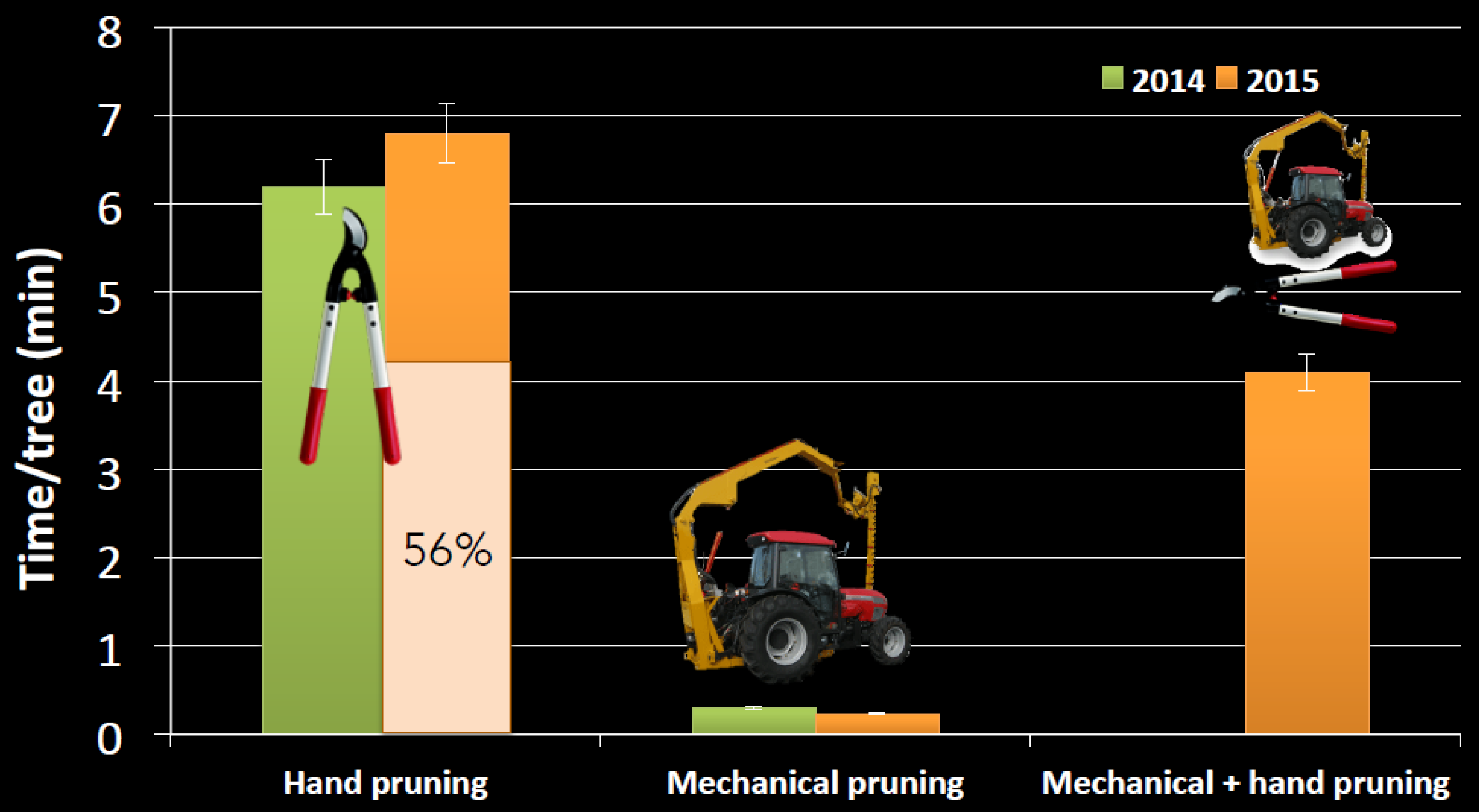
Results: Time



Mech pruning 23 and 29 times faster than hand pruning (hedging and topping) in 2014 and 2015

Combination of manual and mech. pruning was twice as fast as hand pruning (ca. 2.0 km/h)

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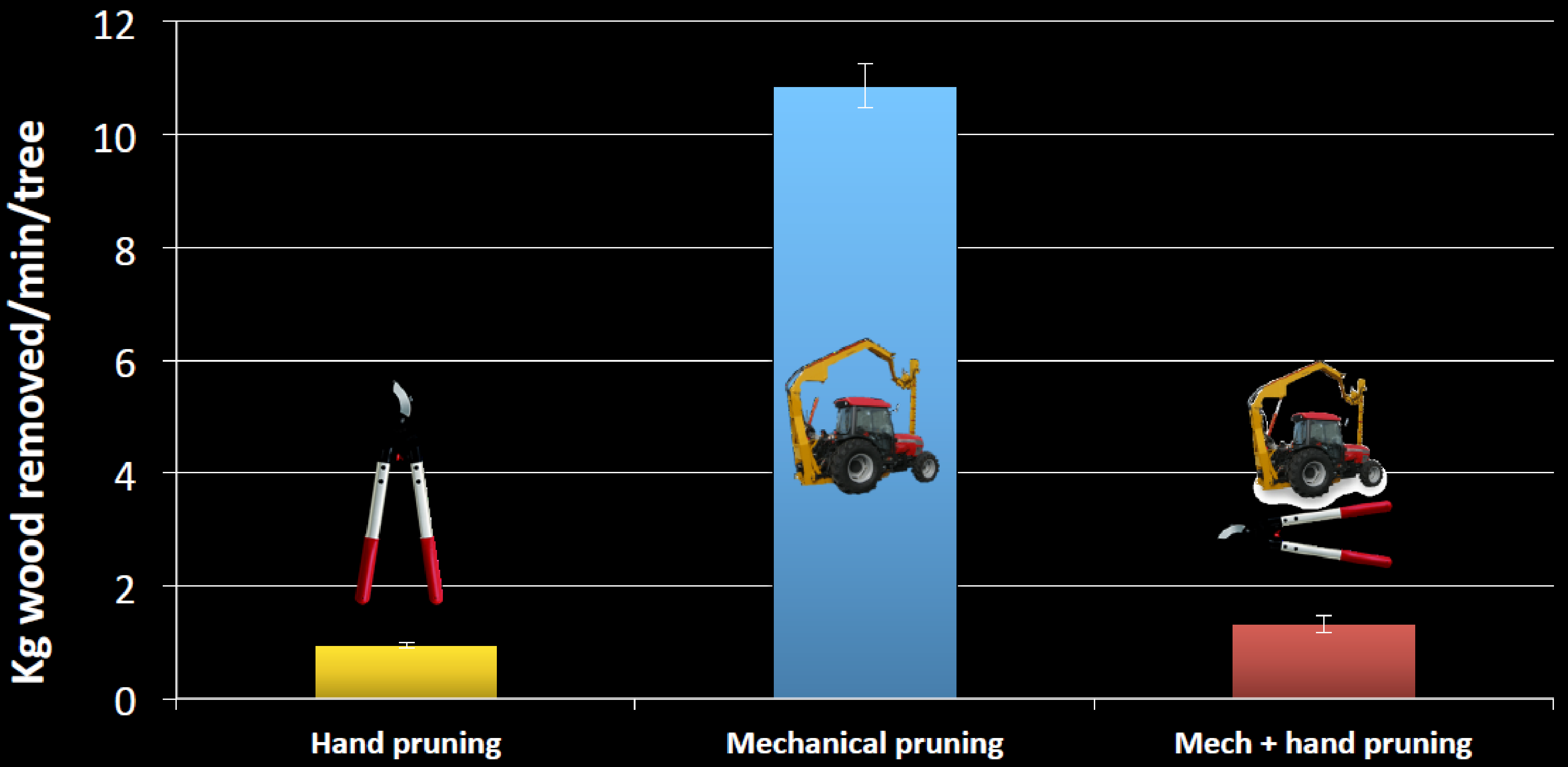
Results: Efficiency 2015



Mech + hand pruning was 66% more efficient than hand pruning alone

Mech pruning was 11 times more efficient than hand pruning

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Pruning and Training Costs

Australia

- Palmette training systems (close planted) 1.75 m x 4 m (1428 trees/ha)
- Use of growth bio-regulators (split applications of 2 ml/tree 4ml/tree total)
- Mechanical pruning in spring & post-harvest topping & hand pruning in winter
- Peach cultivar - TropicBeauty 30% reduction in pruning costs
    - $2.39/tree or $2987/ha
- Nectarine cultivar – Sunwright 31% reduction in pruning costs

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- $2.54/tree or $3175/ha

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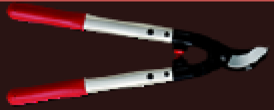
ASSUMPTIONS:

- 1 acre of UFO 'Tieton'/'Gisela5'
- Full canopy
- 1350 trees/ha

1 person
8 hours work/day
$12/h
UFO pruning rules

USA

Estimated pruning costs	
	$741
	$168
	$590

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USA

Trial:

‘Rainer’/’Giselar® 5’

Treatments

- Control (unpruned)
- Hand-pruned
- 20 days before harvest
- 10 days before harvest

Results:

- Mech-assist pruning was 7 times faster than hand
- Slight improvement (+12%) in colour with both timings
- Slight reduction (-9%) in soluble solids at 20 dbh
- Return bloom, regrowth TBD

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Future Cherry Orchards

Washington State University

USA & Australia

What is the future cherry orchard?

Totally new production systems in the foreseeable future (decision aid systems for growers)

- New orchard design
- New trellising systems
- New tree architecture
- New cultivars
- New rootstocks
- New canopy management systems (pruning & training)
- New plant bio-regulators (excessive vegetative growth = poor fruit quality & fruiting capacity)
- New nutritional and irrigation systems (mechanisation of delivery, control & monitoring)
- **Mechanisation or mechanical assistance** of labour intensive tasks (pruning & training, harvesting, post-harvest handling) – use of precision horticulture systems & electronics

Benefits: Reduction in the production system costs

Enhanced fruit quality; yield stability & predictability; profitability& sustainability

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Future Cherry Orchards

What is the future cherry orchard?

USA & Australia

Horticulture Innovation Australia

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Appendix N - NCDP 2016 Road Show events topics presented.

Presenters:

- Deputy Director of TIA, Associate Professor Dugald Close attended the road show event in Vic with the road show team of Associate Professor Matthew Whiting international guest speaker from Washington State University, consultant and cherry expert Mr Peter Morrison and TIA's NCDP coordinator Mr Robert (Bob) Nissen.
- Associate Professor Matthew Whiting, consultant Mr Peter Morrison and TIA's Mr Bob Nissen continued to each of the road show venues in NSW, and SA. Associate Professor Dugald Close returned to Tasmania due to other commitments.
- In NSW, Dr Penny Measham and Mr Dan Ryan joined the team for the road show events at Young and Orange.
- Associate Professor Dugald Close then joined the team for the last road show in Tasmania.

Road Show Topics:

International cherry expert and guest speaker Associate Professor Matthew Whiting provided the latest information on assisted pollination and the automation in future cherry orchards.

Assisted pollination: (Presentation Title: Floral Biology and Pollination Systems in Sweet Cherry)

Associate Professor Whiting indicated that it is well recognised in the literature that obtaining consistent yields for cherries every year is virtually impossible due to a large range of factors. Yield stability is a major industry issue in Australia and the USA. Floral studies undertaken in the USA revealed the stigma reaches maximum receptivity two days after flower opening. Unfavourable environmental conditions can have a significant impact on the stigma receptivity (stigmatic tissue and secretions) resulting in poor pollen germination and ovule fertilisation. New innovative assisted, automated pollination systems have been developed at Washington State University to achieve yield stability. Pollen collection, storage, pollen medium solutions and automated pollen application methods developed in the USA could easily be adapted to suit Australian conditions to enhance cherry pollination and reduce yield instability. However, floral studies on cultivars would need to be undertaken in Australia, to establish if cultivars and flowers exhibit a similar pattern to that seen in the USA.

Cherry orchards of the future: (Presentation Title: Tree Fruit Research at the Intersection of Biology and Technology)

In the second presentation by Associate Professor Whiting, growers were asked to think about what a future cherry orchard may look like in terms of:

- orchard design (trellised close planted tree vs non trellised trees widely spaced)
- light interception levels (vertical tree canopies vs sloping tree canopies and impacts on fruit quality and yield capacity)
- tree architecture (pedestrian free standing trees vs trellised fruiting walls)
- mechanically pruned vs hand pruned (reduction in labour costs and impacts on fruit quality)
- mechanically harvested vs hand harvested (use of platforms, automated picker and harvesting documentation, branch shaking and berry removal, impacts on fruit quality)
- acceptance by consumers of stem-less cherries

Growers all agreed that escalating labour costs in Australia and difficulties in finding suitable pickers are two of the factors affecting Australian cherry growers. The presentation by Associate Professor Whiting focused attention on what their cherry orchards may look like in the future, including tree architecture, automated pruning and harvesting. To remain economically viable growers will have to implement changes, and many growers agreed that they need to change.

Queensland fruit fly management in NSW:

Dr Penny Measham, from the HIA Queensland Fruit Fly (Qfly) Area Wide Management (AWM) coordinator and Mr Dan Ryan Program Director of Sterile Insect Technique (SIT) presented information on the developments within SIT and AWM. Controlling Qfly and market access, wide area management and release of male sterile Qfly were major issues expressed by NSW growers.

Grower discussions: Many growers in the Young and Orange Districts are trying to understand how a systems approach to management of Qfly would work in their respective regions. A systems approach, while all encompassing (undertaking field through to postharvest practices in an effort to control and limit potential Qfly infestations), appears to be some years off in these regions.

However, NSW DPI is conducting research on Qfly infestation periods. A large body of evidence is being collected indicating that Qfly did not breed or lay eggs until the southern NSW cherry harvests were completed. Further research into irradiation of cherry fruit is in progress and a pilot program sending irradiated fruit to Indonesia is in development.

The cherry producing farms are spread throughout the districts and are not aggregated in defined areas. This may limit the potential of wide area management strategies. However, growers in these regions can make substantial gains by understanding and implementing Qfly management strategies (monitoring, infield practices and sterile fly releases etc.) for their individual properties. Possibly the biggest gains will come from the implementation of postharvest disinfestation practices to obtain market access.

Field Walk Topics:

Consultant Mr Peter Morrison conducted the field walks at each location. Mr Morrison discussed the latest information on cherry spur leaf development, and advocated the use of zinc and nitrogen, which influence fruit size and quality, to increase leaf size. He also provided information on the use of Regalis® and Retain® at flowering to improve fruit set and retention. These topics were well received by growers and further topics discussed at all locations included cultivars, timing of flowering, pollinators, rootstocks and fruitlet retention. In South Australia further discussions were held on climatic impacts and development of benchmarking program for growers to assess and determine crop load levels.