Late Autumn Winter Spring strawberries for profit and consumer appeal - 2008/09

Mark Herrington
Department of Employment,
Economic Development & Innovation

Project Number: BS08006

BS08006

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

The research contained in this report was funded by Horticulture Australia Ltd with the financial support of the strawberry industry.

ISBN 0 7341 2150 4

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

HAL

Know-how for Horticulture™

Final Report for Horticulture Australia Limited Project:

BS08006
Late Autumn Winter Spring strawberries for profit and consumer appeal - 2008/09

Mark E. Herrington (et al.)
Principal Horticulturist, Queensland Primary Industries and Fisheries, Department of Employment, Economic Development and Innovation, Maroochy Research Station, PO Box 5083, SCMC, Nambour, Qld 4560
Phone: 07-5453-5950 Facsimile: 07-5453-5901 E-mail: mark.herrington@deedi.qld.gov.au
(2 October 2009)

Author and Co-authors, staff, collaborators and advisors include:

Authors and Co-authors
Mark Herrington[A], Louella Woolcock[B], Lien Ko[C], Michelle Paynter[D]

Project staff (additional)
Don Hutton[E], Apollo Gomez[F], Denis Persley[G], Kathy Parmenter[H], Sam Price[F], Roger Broadley[I]

Collaborators
Craig Chandler[J], Janet Giles[K], Dennis Phillips[L], Aileen Reid[M], Craig Hardner[N]

Advisors:
Chris Menzel[A], Mark Dieters[O], Malcolm Wegener[P]
****

[A]Principal Horticulturist, Queensland Primary Industries and Fisheries, DEEDI, Maroochy Research Station, Nambour, Qld
[B]Field Assistant Queensland Primary Industries and Fisheries, DEEDI, Maroochy Research Station, Nambour, Qld
[C]Senior Research Scientist, Queensland Primary Industries and Fisheries, DEEDI, Maroochy Research Station, Nambour, Qld
[D]Laboratory Assistant, Queensland Primary Industries and Fisheries, DEEDI, Maroochy Research Station, Nambour, Qld
[E]Senior Experimentalist, Queensland Primary Industries and Fisheries, DEEDI, Maroochy Research Station, Nambour, Qld
[F]Experimentalist, Queensland Primary Industries and Fisheries, DEEDI, Maroochy Research Station, Nambour, Qld
[G]Senior Plant Pathologist, Queensland Primary Industries and Fisheries, DEEDI, Indooroopilly Research Centre, Indooroopilly, Qld
[H]Plant Pathologist, Queensland Primary Industries and Fisheries, DEEDI, Indooroopilly Research Centre, Indooroopilly, Qld
[I]Science Leader, Queensland Primary Industries and Fisheries, DEEDI, Maroochy Research Station, Nambour, Qld
[J]Plant Breeder, University of Florida, CGREC Balm, Florida USA
[K]Senior Biometrician, Queensland Primary Industries and Fisheries, DEEDI, Animal Research Institute, Yeerongpilly, Qld
[L]Senior Development Officer (Horticulture), Department of Agriculture and Food Western Australia, South Perth, WA
[M]Development Officer (Horticulture), Department of Agriculture and Food Western Australia, South Perth, WA
[N]Research Fellow, LCF&S, University of Queensland, St Lucia, Qld
[O]Senior Plant Breeder, LCF&S, University of Queensland, St Lucia, Qld
[P]Economist, formerly, University of Queensland, St Lucia, Qld

The purpose of this document is to report on the activities and outcomes of HAL project BS08006.

We acknowledge the funding support of the Queensland State Government through its Department of Employment, Economic Development and Innovation (Queensland Primary Industries and Fisheries), the Australian Federal Government and Strawberries Australia Limited through Horticulture Australia Limited.

Thanks also to the many field staff including Mary Grace, Warwick Grace, Helen Hutton, Lindsay Smith, Sharon Anning, Jeremy Rousham and the many collaborating growers.

Date of Report 06/10/2009

Industry summary

Strawberries are delicious fruit with national production valued at about $250m. There are two major production periods, the 'Late Autumn Winter Spring' (LAWS) period focused on SE Queensland; and remaining production period focused in Southern states with a smaller focus north of Perth WA.

The necessary profitability in the competitive global market can be increased by cultivars that: minimise plant losses, labour requirements, variations in labour requirement, and maximise pack-out percentage, consumer appeal, enjoyment and choice in the supply chain. Our strategic one year LAWS project was developed to achieve a 'business as usual work' approach while strategically aligning national longer term research efforts and priorities, embracing applicable frontier technologies and using information in a smart manner to develop new cultivars. The program was initiated to produce: a new breeding project proposal; at least one cultivar released to final testing stage; and documented progress toward a suite of new strawberry cultivars with improved production characteristics and high consumer acceptance and suitable for planting in all relevant Australian production areas.

We developed an innovative project 'National strawberry varietal improvement program – subtropical regions' HAL R&D project (BS09013) following extensive stakeholder consultations and project modifications.

We identified from glasshouse inoculation trials two (17337 and 13581) of nine isolates of *Fusarium oxysporum* f.sp *fragariae* as highly pathogenic and which could be used in breeding *Fusarium* resistant cultivars to reduce plant losses and improve industry economics.

We implemented a crossing and introduction and evaluation schedule for the 2008-2009 season, with a focus on larger fruit size, productivity and high consumer acceptability comprising 48 parents, 14500 seedlings and 362 clones. The finally selected 18 primary clones promise significant progress toward our long term target of equalising production from May 1 to Sept 30 at 60g/plant/week. For example while Festival, the current major cultivar, had 3-4 of 17 weekly harvests where yield was at least 60g/plant, some project clones (2006-475, 2007-302) doubled the frequency (10 of the 17 weekly harvests) toward the target production characteristic.

Samples of nineteen high quality productive selections were established 'on-farm' locally and interstate. In the 'advanced stage' 'on-farm' trial, selection '2006-019' and '2006-215' were of most continued interest among project selections, while the intermediate stage trial line '2006-475' also performed well in 'on-station' and initial 'on- farm trials'. One grower reported that he expects total yields of 2kg per plant by end October from '2006-475'.

The technological and advanced selection outputs from this project should position the subtropical and national strawberry industry and its genetic improvement programs in an excellent position for further progress.

Technical summary

Strawberries are delicious fruit with national production valued at about $200m. There are two major production periods the 'Late Autumn Winter Spring' (LAWS) period focused on SE Queensland; and remaining production period focused in Southern states while the production area north of Perth WA is considered as a third region falling between the others.

Being profitable is the imperative to maintain an Australian strawberry industry which must be competitive in the global market. This competitive position involves strategically aligning research efforts, embracing applicable frontier technologies and data management. In the longer term the cost price structure can be positively influenced by efficiently breeding varieties that: minimise plant losses, labour requirements, variations in labour requirement, and maximise pack-out percentage, consumer appeal, enjoyment and choice in the supply chain.

This strategic one year LAWS project was developed in context of the strawberry industry strategic investment plan and the Australian Government's National Research Priorities following Horticulture Australia Limited's (HAL) request to balance a one year program with a longer-term research outlook. The requested 'business as usual work' was applied in the context of strategically aligning national research efforts, embracing applicable frontier technologies and using information in a smart manner.

Consequently a program was initiated to produce: a new breeding project proposal involving frontier technologies and smart data management; identified potential sources of resistance to wilt diseases; at least one cultivar (breeding line) released to final testing stage; and documented progress toward a suite of new strawberry cultivars with high consumer acceptance and improved production characteristics suitable for planting in all relevant Australian production areas and involving the introduction of new technologies. These actions and outputs are reported here.

We developed an innovative project 'National strawberry varietal improvement program – subtropical regions' HAL R&D project (BS09013) following extensive stakeholder consultations and project modifications. Its outputs should position the subtropical and national strawberry genetics improvement in an excellent position for the immediate and future industry needs.

We identified from glasshouse inoculation trials two (17337 and 13581) of nine isolates of *Fusarium oxysporum* f.sp *fragariae* as highly pathogenic on the susceptible cultivar 'Kabarla' and which could be used in future breeding of *Fusarium* resistant cultivars. Such resistance, as identified previously in 'Sugarbaby' should reduce plant losses and improve industry economics.

We used the techniques, findings and recommendations reportedly recently in HAL project 'BS06001' to implement a crossing and introduction schedule for the 2008-2009 season, with a focus on larger fruit size, productivity and high consumer acceptability and trial plants were grown in cells.. The initial crossing set comprised 48 parents. Approximately 14500 of the combined 2008-2009 -series seedlings were evaluated with 274 being carried forward into 2009.

We selected 18 primary and 30 secondary selections of 88 clones from the 2006-2007- series through the evaluation of later stage clones over a 17 week production period from 1 May. The selected clones promise significant progress toward our long term target of equalising production from May 1 to Sept 30 at 60g/plant/week. While Festival, the current major cultivar, had 3-4 of 17 weekly harvests where yield was at least 60g/plant, some project clones e.g. 2006-475, 2007-302 had 10 of the 17 weekly harvests in the category. This doubling of the frequency of the target production by project lines is a significant step towards achieving the longer term objective and implies effective progress toward positive changes in the cost price structure.

Samples of seven 'advanced-stage, twelve 'advanced early stage' high quality productive selections were established 'on-farm' locally and interstate. The 'advanced stage' trial lines 2006-019 and 2006-215 were of most continued interest of project selections. Additionally the intermediate advanced stage trial line '2006-475' performed well in both on-station and early 'on- farm trials' eliciting a grower response of: 'This is one which must be seriously promoted for the future of the strawberry industry. It performed well all season.' Total yields of 2kg per plant by end October were expected by the grower.

The outputs of technology and advanced selections should position the subtropical and national strawberry genetics improvement in an excellent position for the immediate and future industry and national needs.

CONTENTS

1. INTRODUCTION

Strawberries are delicious fruit with national production valued at about $200m. Traditionally in Australia there are two major production periods based on latitude. The 'Late Autumn Winter Spring' (LAWS) period is heavily focused in SE Queensland; and the 'Spring Summer Autumn' (SSA) production period focused in Southern states and also south of Perth near Albany WA, while the production area north of Perth WA although close to LAWS should be considered as a third region falling between the LAWS and SSA (Herrington *et al.* 2008).

Being profitable is the imperative to maintain an Australian strawberry industry which must be competitive in the global market. Profit is the difference between costs and returns (prices) and can be increased by reducing costs or increasing prices. Prices are in essence determined by supply and demand for the product. Developing a competitive position for the national industry involves strategically aligning research efforts, embracing applicable frontier (in the sense of 'cutting edge') technologies and using information in a smart manner to fast-track breeding outcomes.

The production and marketing environments in Queensland – the major sector of the LAWS market is similar to Florida were recently reviewed and are summarised as follows (Herrington and Chandler 2006):
Production involves annually planting bare rooted green-leaf or leafless runners into variously coloured-polythene-covered raised beds to give about 40,000 plants/ha (Legard *et al.* 2003; Vock and Greer 1997). Plants remain uncovered and so are exposed to the weather. Queensland occasionally has frosts but does not experience the 'freezes' of Florida. In Queensland, following bulk harvest in the field, fruit are pre-cooled then individual fruit are graded and packed into 250-550g containers in a packing shed (Vock and Greer 1997). By contrast, in Florida fruit are placed in the final pack in the field prior to cooling (Brown 2003). Fruit are harvested from late autumn to early spring and shipped to markets located 100 to 2000km from the production source. Fruit are usually at these markets within 1-4 days of harvest.

Most Queensland plants (95%) are grown in the Caboolture to Noosa region just north of Brisbane, while those areas close to the LAWS production environment in Western Australia are around Wanneroo just North of Perth.

The production cost structure is impacted by some of the following. All fruit are individually harvested, graded and packed using hand labour. In LAWS, production per week per plant increases as the size of the plant increases, with natural flowering, with sequential fruiting cycles and with different varieties. These cause large variations in production per week, with correspondingly large fluctuations in the labour requirement and prices received. The instability of production, the consequent inefficiencies of labour management and depressed prices are significant issues for the industry. This is exacerbated by increasing losses to wilt diseases, such as *Fusarium* spp., *Colletotrichum gloeosporoides*, *Cylindrocarpon* spp. and *Macrophomina phaseolina* (D Hutton, pers. com 2006).

In the longer term the cost price structure can be influenced by efficiently breeding varieties that: minimise plant losses, labour requirements, variations in labour requirement, and maximise pack-out percentage, consumer appeal, enjoyment and choice in the supply chain. Breeding has the potential to improve returns by

developing cultivars with high productivity, regular flowering, easily accessible fruit and fruit with high consumer appeal.

The one year LAWS project was developed strategically following Horticulture Australia Limited's (HAL) request to balance a one year program with a longer-term research outlook. It was designed in the context of the strawberry industry strategic investment plan 2004-2008 and the Australian Government's National Research Priorities, so that business as usual could be conducted while an exit strategy from the Victorian Department of Primary Industries Strawberry Breeding program was developed conjointly between HAL and industry, and at the same time provide initiatives to progress a step towards future varieties. The 'business as usual work' and in the context of strategically aligning national research efforts, embracing applicable frontier technologies and using information in a smart manner is reported here.

Consequently a program was initiated to produce:
A new project proposal involving frontier technologies and smart data management including BLUP Breeding value estimation, marker assisted selection, supply cycle integration, disease resistance, flavour and consumer assessments.
Potential sources of resistance to wilt diseases identified.
Release to testing stage of at least one cultivar.
Documented progress toward a suite of new strawberry varieties with high consumer acceptance and improved production characteristics suitable for planting in all relevant Australian production areas.

2. SPECIFIC EXPERIMENTS

2.1. Breeding - Field culture, crossing and basic evaluation

2.1.1. Materials and methods

The basic cultural, evaluation and selection of parents and progeny procedures were mostly as described previously (Herrington *et al.* 2008) for Maroochy Research Station and Bundaberg Research Station (BRS). Additionally all on-station and farm trial plants were from cell-grown plants. Except for a sample sent to Western Australia and Bundaberg all seedlings were planted directly to potting mix and were not subjected to a tissue culture phase.

Fruit were generally harvested once weekly from April/May through September, weighed and counted. In 2009 in 'advanced' trials where fruit are separated into 'large' and 'small' the threshold 'small fruit' classification was raised from <10g to <15g. The standard cultivars used for comparison were Festival and Rubygem.

2.1.2. Results and discussion

2.1.2.a. Crossing.
Based on the techniques, findings and recommendations reportedly recently in HAL project 'BS06001' (Herrington *et al.* 2008), a crossing schedule was developed and implemented for the 2008-2009 season, with a focus on larger fruit size, productivity and high consumer acceptability. The initial crossing set comprised 48 parents emphasising 2004-290, 2006-273, 2006-475, 2006-262 and Rubygem.

2.1.2.b. Seedling selection and evaluation for 2008-2009.
Approximately 4500 of the 2009-series and 6800 of 2008- series seedlings were evaluated in the field at Maroochy and Bundaberg Research Stations. Two hundred and seventy four '2008- series' selections were drawn from the seedling population and carried forward into 2009 . This comprised 153 from an original main breeding trial (from initial 185 selections) and 121 from a section of the breeding population emphasising rain damage response. The selections within the 2008- and 2009- series will be finalised under project (BS09013).

2.1.2.c. Evaluation and selection of 1st, 2nd and some 3rd stage selections
Clones (i.e. 2008-, 2007- and 2006- series) were evaluated over a 17 week production period from 1 May through end of August. We selected 11 of 57 clones from the 2007- series and seven of 31 clones from the 2006- series for further field evaluation while keeping an additional19 and 11 clones of 2007- and 2006- series respectively for further crossing, or maintenance. These clones promise significant advantages as follows.

One proposed target in the next six years, as nominated in this project's proposal, was to effectively equalise production from May 1 to Sept 30 at 60g/plant/week. In the present trial Festival, the current major cultivar in LAWS production areas, had only 3-4 of 17 weekly harvests where yield was greater than 60g/plant/week. By contrast some project clones eg 2006-475, 2007-302 had 10 of the 17 weekly harvests where yield was at least 60g/plant. This doubling or tripling the frequency of the target production by project lines is a significant step towards achieving the longer term objective of equalising production from May 1 to Sept 30 at 60g/plant/week.

2.1.2.d. 'On-farm' pre-commercial testing;
Seven 'advanced-stage', high quality productive selections 2005-159, 2005-180, 2005-188, 2005-189, 2005-261, 2005-281, 2006-019 were established on farms in Queensland, South Australia and NSW/ACT for 'late-stage' pre-commercial tests. Quarantine difficulties precluded 'on-farm trials' in Western Australia and Tasmania and no trial sites were available in Victoria. Additionally in Queensland two 'early-stage' pre-commercial testing trials of twelve high quality productive lines 2006-079, 2005-063, 2005-153, 2006-262, 2006-473, 2006-475, 2007-316, 2007-286, 2007-302, 2007-307, 2007-046, 2007-245 were established 'on-farm'. 'Very advanced lines 'released to testing stage' were also incorporated on-farm in runner grower (Red Jewel) trials in Queensland. The 'advanced stage' trial lines 2006-019 (Fig. 1) and 2006-215 were of most continued interest and will be followed through with PBR applications. Additional plants of test clones will be indexed to increase the supply of elite clones.

The performance of trial line '2006-475' (Fig 1.) in both on-station and early 'on-farm trials' is of special note. Growers' descriptions of the trial line '2006-475' are very supportive eg one grower wrote: "This is one which must be seriously promoted for the future of the strawberry industry. It performed well all season...' Additional comments implied that consumer acceptability would be good and total yields in excess of 2kg would be likely by end October (that '2006-475' had produced 1.1 kg by mid September and from flower and fruit set it was estimated there would be another 1.0 kg within the 'next 5-6 weeks'.

Fig 1. Advanced selections '2006-019'(left) and 2006-475 (right).

2.2. Fusarium resistance : Comparisons of pathogenicity of *Fusarium spp.* isolates on strawberry for use in breeding line and cultivar screening – (Michelle Paynter, Don Hutton, Apollo Gomez, Mark Herrington)

2.2.1. Materials and methods

We sought to determine the pathogenicity of isolates of *Fusarium oxysporum* f.sp *fragariae* (*Fof*) in strawberry plants so that suitable isolates could be used for breeding line and varietal resistance screening work. This necessary activity delayed proposed varietal comparison which will be progressed in BS09013.

Pathogenicity tests were conducted in two glasshouse experiments at Maroochy Research Station at Nambour (Fig. 2). Nine isolates of *Fusarium spp* (N13581, N15309, N15457, N16004, N17337, N18419, N18421, N18440, N18462) were separately tested by root dip inoculation with spore suspensions ($1.0 \times 10^{6)}$ spores /ml) on 5 plants of the susceptible cultivar Kabarla. The isolates originated from farms in Queensland and Western Australia. The isolate N18462, associated with episodes of a high incidence of crown rot in the 2005 and 2006 seasons in Western Australia (Phillips & Golzar, 2008), was used as a positive control. Scoring ranged from 0 = plant healthy with erect growth and full vigour, to 10 = plant dead.

2.2.2. Results and discussion

The severity of symptoms in plants varied between treatments. Three weeks after inoculation several plants began to wilt, while others expressed wilting symptoms several weeks later. Two plants inoculated with isolate 15457 did not show wilt symptoms until six weeks after inoculation with the spore suspension.

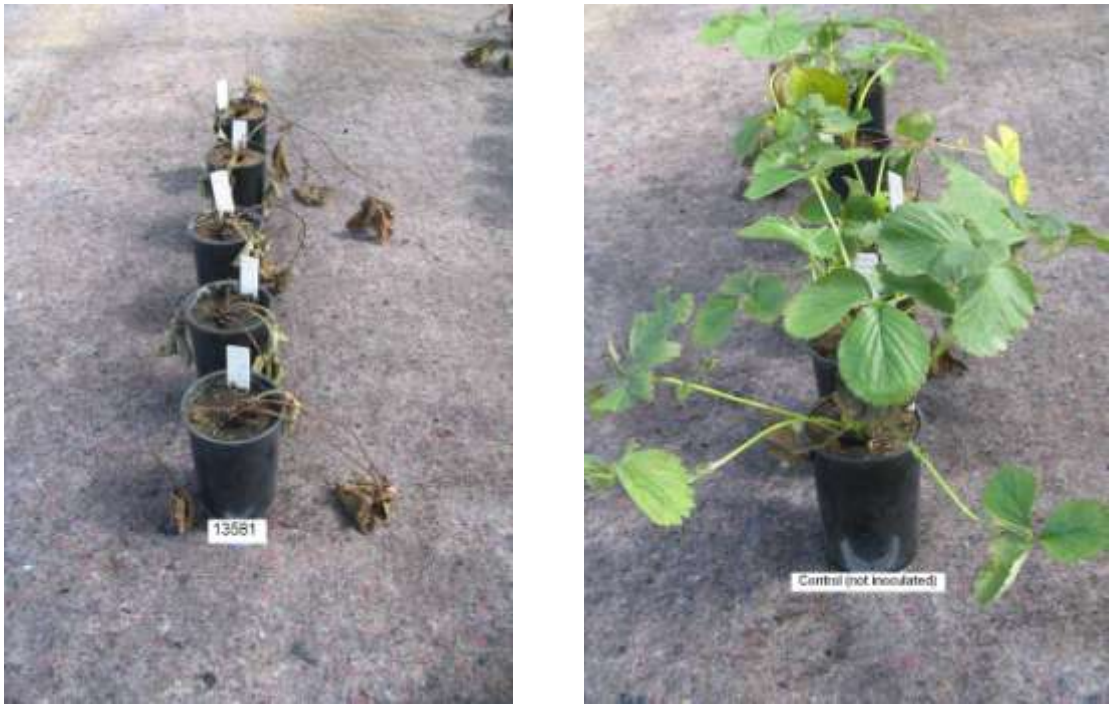

Fig. 2. Five weeks after inoculation, symptoms of collapsed and desiccated plants are evident on the plants inoculated with isolate 13581 (left) compared to the control (right)

Two isolates 17337 and 13581 were highly pathogenic, with all plants either wilting and collapsed, or dead (Fig. 2). Both isolates scored 9.4 for the visual ratings and could be used in resistance screening.

2.3. Development of improved breeding procedures – data management

2.3.1. Materials and methods

The LAWS region projects have traditionally relied on 'Microsoft Excel' spreadsheets for data management. Larger data sets, looking back into historical pedigrees and larger numbers of trial sites will require more efficient data management through database storage. Databases that had capacity to handle large data sets, accessibility of expertise and likelihood of on-going support were considered in selection the database.

On-station LAWS trial data from 2004-2008 in 'Microsoft Excel' spreadsheets were collated and subjected to verification and manipulation to make it amenable to entry into the 'Katmandoo' database. Pedigree files were included. Additionally analyses with ASREML and BLUP estimates were applied to seedling data on rain damage and subsequently to selected clones (2008-series) from the seedling set.

2.3.2. Results and discussion

'Katmandoo' database was chosen because of its capacity to handle large data sets, accessible expertise (UQ and QPIF) and likelihood of on-going support.

The ASREML and BLUP estimates analysis indicated that 'Festival' and 'Rubygem' contributed less significant effects to resistance and susceptibility to rain damage, respectively than expected. However clones 2004-199, 2006-016 and 2006-013 contribute significant positive effects. While heritability (narrow sense) was only low

to moderate (14%) in the seedling evaluation the analysis of the selected progeny indicate higher (48%) heritability (narrow sense) levels on the plot mean basis. This implies high levels of resistance to rain-damage can be achieved, although the extent of development will be limited by any adverse correlation with other characters which need to be determined. Additional analyses will be explored in the coming project (BS09013) after the final upload of the data into the data base which is expected to occur in the next few weeks.

2.4. DNA applications

2.4.1. Materials and methods

'Blind' samples representing approximately six cultivars were sent to AgGenomics for DNA extraction and clonal sample-matching as part of a collaborative effort.

2.4.2. Results and discussion

All pairs of the sample clones were correctly matched. Thus the available technology and infrastructure is capable of identifying matches to reference genotypes and which would be useful in ensuring trueness to type in propagation and storage facilities. However because the available southern Australian Day Neutral markers appear to be population specific they could not at present be successfully validated in our subtropical populations.

2.5. Supporting Interstate industry efforts

2.5.1 Materials and methods

As a pilot study in support of the national industry a small sample of the germplasm (65 seedlings) were produced and aseptically prepared in Queensland. This involved strategic crossing, tissue culture and *in vitro* plant maintenance. They were then sent to Western Australia where they were de-flasked into containers (seedling trays) and subsequently field planted at Wanneroo under direction of Aileen Reid (Western Australia Department of Agriculture and Food).

2.5.2. Results and discussion

Sixty –one of the plants established in the field at Wanneroo. While the economics of a 'scale-up' remain to be determined, this small scale trial provides an initial 'proof of concept' for a crossing and plant management system that would facilitate rapid development and deployment of new lines from the Queensland 'LAWS node' of the national program into Western Australia.

3. GENERAL DISCUSSION

3.1. Outputs

The intended outputs of the project (BS06002) were well met:

Approximately 10% (3-4 million plants) of 2009 season subtropical plantings (Queensland) are to cultivars developed in previous projects associated with the subtropical (LAWS) node. The trial lines 2006-019 and 2006-215 (above) which have performed well non-farm trials are available for commercial trial and will be followed through with PBR applications in project BS09013. The large fruit size of 2006-019 ensures rapid increase in yield relatively early in the season. PBR trials for 'Parisienne Belle' were finalised and description will be prepared and submitted under project BS09013. The innovative trial line 2006-475 will also be developed to PBR status with high demand expected when it is available. Together these lines are expected to substantially increase the size and proportion of plantings of project cultivars in subtropical and other areas and open opportunities for cultural changes.

A new project proposal involving frontier technologies and smart data management including BLUP Breeding value estimation, marker assisted selection, supply cycle integration, disease resistance, flavour and consumer assessments has been developed and submitted to HAL for final approval. This innovative project 'National strawberry varietal improvement program – subtropical regions' HAL R&D project (BS09013) was developed following extensive stakeholder consultations and project modifications. Its outputs should position the subtropical and national strawberry genetics improvement in an excellent position for the immediate and future industry needs.

Although potential sources of resistance to wilt diseases were not identified, appropriate highly pathogenic isolates of *Fusarium* were identified and these will promote the screening and selection of resistance in the future.

The trial lines 2006-019 and 2006-215 which have performed well in on-farm trials and are released or pending (2006-475) to be available for commercial trial exceed the project target output of 'release to testing stage of at least one cultivar'.

The high (10/17) frequency of weeks with production at more than 60g/plant/week, again featuring '2006-475', compared to the 3-4/17 for dominant current commercial cultivar('Festival') documents progress toward the longer term objective of a suite of new strawberry varieties with high consumer acceptance and improved production characteristics suitable for planting in all relevant Australian production areas.

3.2. Outcomes

The intended outcomes of the project (BS06002) were also relatively well progressed or met:

There is national recognition of the transition into an effective national project with two or three relevant nodes of activity. There is a high level of support by industry for the proposed new national project. The proposal integrates supply cycle features and advanced technology which will deliver benefits through increased use of local cultivars. This is seen as efficient resource management. The support for the project

and cultivars is encapsulated by a grower report about a trial lines influence on the industry "This is one *(trial variety)* which must be seriously promoted for the future of the strawberry industry".

The high yields of new breeding lines progress towards the longer term outcomes of Improved productivity, improved uptake of project cultivars – and improved breeding strategies.

4. TECHNOLOGY TRANSFER

4.1. Industry publications include:

Herrington, M., Moisander, J. and Woolcock, L. (2008) 'Plant Breeding' 2008 Edition Strawberry R&D Update p 3-5

Ko, L., Moisander, J., McFarlane and Herrington, M. (2008) 'Biotechnology' 2008 Edition Strawberry R&D Update p 6-9

Herrington M. (2008) *submission to* 'Breeding program focuses on high quality strawberries'. Horticulture Australia Limited: Strawberry Annual Industry Report 07/08 p 11

4.1.1. Oral presentations to industry include:

QSGA growers meeting October 10 2008.

Strawberry breeding and advanced selections QSGA field day 6 May 2009.

QSGA executive and state Strawberries Australia 'QDPI strawberry breeding' 3 February 2009.

4.1.2. Other Activities include:

Strawberry – an oral presentation on strawberry breeding project work to QFFAC (Queensland Food, Fibre and Agribusiness Council) 29 July 2008.

4.2. Scientific publications include:

Chandler C, Folta K , Dale A, and Herrington M (2009 submitted) 'Strawberries' *Chapter In multi-volume handbook of crop breeding - Springer'*

4.2.1 Other scientific publications include:

Herrington, M. E., Dieters, M., Wegener, M., Woolcock, L. and Moisander, J. (2008). Strawberry cultivars differ in their tolerance to damage by rainfall. *TransTasman AuSHS conference- Smart Science for Innovation in Horticultural Enterprises.* Surfers Paradise on 21-23 July 2008.

Herrington, M., Moisander, J., Woolcock, L., Ko, L., Taylor, L., Smyth, H., and Reid, C. (2008). Final Report for Horticulture Australia Projects: BS01005- Australian strawberry breeding program - Late autumn, winter and spring markets: *and* BS06001- Late Autumn Winter Spring strawberries for profit and consumer appeal (with extensions) pp48.

Herrington, M.E., Woolcock, L., Wegener, M., Dieters, M. and Moisander, J. (2009). Cultivar differences in tolerance to damage by rainfall. Acta Horticulturae (ISHS) 842:483-486

5. RECOMMENDATIONS

Continue progress to implement recommendations made in project report BS01005 & BS06001

Rapidly implement virus indexing and production of nuclear and foundation plants of advanced lines especially ‘2006-475’ to allow national testing, promotion and commercialisation.

Bibliography

Brown M (2003) A Florida strawberry production and marketing enterprise. In 'The Strawberry; a book for growers, others'. (Ed. NF Childers) pp. 31-42. (Dr Norman F. Childers Publications Gainesville, Florida).

Herrington M, Moisander J, Woolcock L, Ko L, Taylor L, Smyth H, Reid C (2008) Final Report for Horticulture Australia Projects: BS01005- Australian strawberry breeding program - Late autumn, winter and spring markets: and BS06001- Late Autumn Winter Spring strawberries for profit and consumer appeal (with extensions). Department of Primary Industries and Fisheries, Queensland, Brisbane.

Herrington ME, Chandler CK (2006) Strawberry breeding in a subtropical environment. *Acta Horticulturae* **708**, 441-447.

Legard DE, Hochmuth GJ, Stall WM, Duval JR, Price JF, Taylor TG, Smith SA (2003) Brief: strawberry production in subtropical Florida. In 'The Strawberry; a book for growers, others'. (Ed. NF Childers) pp. 26-30. (Dr Norman F. Childers Publications: Gainesville, Florida).

Vock NT, Greer GN (1997) 'Strawberry information kit. (Agrilink).' (Department of Primary Industries, Queensland).