UPDATE

NATIONAL PASSIONFRUIT BREEDING PROGRAM (PF15000)

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PF15000 National Passionfruit Breeding Program (NPBP) has been funded by Hort Innovation, using the passionfruit research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

As we reported in the last edition of The Passion Vine, an independent technical review of the passionfruit breeding program was undertaken through the investment Technical Review: National Passionfruit Breeding Program (PF18000), commissioned by Hort Innovation on the advice of the passionfruit industry's Strategic Investment Advisory Panel (SIAP).

The aim of the review was to provide recommendations to Hort Innovation and industry regarding the program's ongoing capacity, technical capability and implemented breeding strategy for the delivery of outcomes identified in the Passionfruit Strategic Investment Plan (SIP).

It is important to note here that the levy funds available for investment in passionfruit R&D projects have been fully committed up to 30 June 2020. The projects which are currently funded by this levy are:

PF16003: National Passionfruit Communication Programme: PAI - which funds all of our magazine, e-news, website and field days until 30 June 2021

PF15000: Passionfruit Breeding Program: SCU - Currently contracted until 31st July 2019

PF18002: Postharvest Best Practice Review: AHR – in progress with a best practice guide due to be published later in 2019

MT17019: Regulatory support and coordination (pesticides): AKC Consulting – an ongoing cross-sector project to keep up-to-date with international pesticide regulation

PF16000: Passionfruit industry minor use program: Hort Innovation provide support to help us to access new chemicals

WHAT HAPPENED?

The review process commenced in December 2018 and concluded in February 2019. The review was conducted by an independent reviewer. During the review process, more than 30 stakeholders were engaged through open table forums and one-on-one interviews. This included 27 growers and industry members across northern New South Wales, South East Queensland and North Queensland.

The reviewer then presented the findings and recommendations to Hort Innovation and members of the passionfruit SIAP. These have been considered holistically in view of grower expectations and the delivery of outcomes identified by the Strategic Investment Plan (SIP).

Hort Innovation then commenced discussions with the breeding program's research team at Southern Cross University to implement the recommendations suggested by the independent review to deliver outcomes to growers.

To implement the recommendations that have been suggested from the independent review, a key change that has been agreed as part of the review process is an extension of the existing project to June 2020. The program will not be provided any more levy funds during this extension period. It is expected that the breeding team will commence the implementation of the review recommendation during this extension.

The SCU team will continue to work to maintain the core activities of the breeding program and implement the recommendations with reduced staff time and the support of a Masters student.

All recommendations and the next steps for each activity, where relevant, are discussed here.

1. **National Passionfruit Breeding Program staff to conduct all future crossing of passionfruit and development of program germplasm in-house**

   Commencing early 2019, all controlled pollinations (crossing and selfing) has been carried out by SCU project staff. Modified procedures for controlled pollination were developed and implemented with more than 340 controlled pollinations carried out to date. Selfing a number of lines has not been possible due to self-incompatibility.

2. **Explore use of and implement breeding and rapid generations techniques in greenhouse and poly-tunnel facilities**

   Poly tunnel and greenhouse space at the DPI NSW facility at Wollongbar and SCU campus has been secured for use in the project. A separate proposal has been put to PAI to co-fund a Master of Science (MSc) student to research and document a rapid generation cycling technique for passionfruit breeding. Once established it will serve as a tool to accelerate the

development of new true from seed (true breeding) varieties. Read more about this on PAGE 16.

3. **Implement a) an inbred breeding program for P. flavicarpa panama type variety development and rootstock development and b) the inbred and true F1 hybrid breeding program for P. edulis scion types originally proposed as part of PF15000**

   This recommendation can make use of findings from the Master's project described in 2 above. SCU have carried out initial inbreeding of Panama and rootstock crosses this season, including overseas sourced material, however no further breeding of Panama and rootstock lines will be possible during the one-year extension period.

   Inbreeding of scion varieties has been continued and expanded in the current season, however constraints to this process have been discovered in some lines. Continuation of this process would depend on a successful Master's project being carried out.

4. **Develop, document and implement a regimented field trialling program with clear stage-to-stage advancement criteria and advanced trial locations in all three growing zones**

   The stage-to-stage advancement process of field trialling has been optimized and documented for use in future stages of the program.

   In 2019/20, staff visits to trial sites will only be possible for northern NSW and SE Queensland, due to travel time and cost restrictions. For future stages of the breeding program, it is proposed that three representative breeding zone locations will be used for stage 3 trialling (one in northern NSW, one in SE QLD and one northern QLD).

5. **Secure long-term agreements for field trial program test locations directly with growers where possible**

   For consistency and long-term utility of data, continued use of the same trialling sites over extended periods of time is highly beneficial. It is important to note here that Hort Innovation is not aware of any other industry where growers are "paid" to host trial plants for breeding trials at their farm site.

   With the limited funds that we have within our industry levy, a successful breeding program is going to continue to rely on the very active participation at the trialling stage by growers across Australia.

   One key change in future will be the use of more structured data capture for trialling feedback than has been used to date.

6. **Collect and analyse phenotypic and quality data for all field trials sown**

   Resource limitations mean that this is currently not feasible. During the project extension, methodology for a more thorough assessment will be tested for a set of 200 vines to be grown at the program arboretum site at Alstonville, northern NSW.

   Continuation of assessment of current Stage 3 trials will be limited during the extension period. Limited further assessment of the ongoing rootstock trials may also be possible during this time.

   The current scoring sheet for Stage 1 trials is believed to be appropriate, however revised scoring sheets for Stage 2 and 3 trials have been constructed to facilitate an improved system of scoring.

7. **Begin genetic and limited phenotypic characterisation of seed bank material**

   While desirable, this aspect was not included in the original project scope and will not be possible within the next year, due to resource restrictions. This could be revisited within the scope of a new project.

8. **Restructure and supplement existing staffing costs**

   The project staffing will be re-structured for the final year to weight more towards technical staff and add the Masters student as a supplement. The technical staff will be responsible for maintaining the arboretum at Alstonville and planting out the new Stage 1 trial vines in September 2019 along with a small number of elite lines to round out the collection.

   At this point, all new DNA marker development work will go on hold, and instead all resources will be allocated breeding and evaluation activities.

9. **Report nomenclature changes to focus the NPBP trialling program on selecting phenotype**

   In simple terms, this recommendation proposes a change to the naming system that is used to keep track of the crossing activities and the resulting trial plants.

   Plants will no longer be referred to as "Lacey x Sweetheart" for example, to remove any bias from the evaluation process. This has been partially implemented in the rootstock and Panama program to remove bias of triallists and assessors. This system will be carried into, tested and refined in the Stage 1 trials for 2019.

10. **Improve engagement with and communication with the industry stakeholders including the NPBP Steering Committee**

    Good communication between the project service provider – SCU – and the industry is fundamental to the success of this program. There is a Steering Committee for this project, but it needs more grower members. The Steering Committee will only meet twice per year and one of those meetings will be a teleconference style – so not a huge drain on your time, but the time invested for the future of the industry is critical.

    The composition of the last steering committee included the following growers: Jim Gordon & Keith Paxton – Sunshine Coast, Qld; Ian Constable – Tweed Valley, NSW; Ross Brindley – Bundaberg, Qld.

    We need more input from Far North Queensland and northern NSW – please contact Amanda Roy to find out more.

11. **Urgently seek definitive independent legal advice regarding the 'Freedom to operate' for the purposes of breeding only with passionfruit germplasm that is not patented, germplasm that is not covered by Plant Breeders Rights and germplasm that only have non-propagation agreements**

    The NPBP has been hampered from the beginning with confusion over what existing plant material can be legitimately included as an input material into the NPBP.

    The simple answer is that ALL material that exists in Australia – even plants covered by Plant Breeders Rights – can be used as an input into a breeding program, providing certain conditions are met, like any subsequently bred plants are not what is known as 'essentially derived varieties' e.g. varieties that share all the essential characteristics of a registered plant variety.

    The program will seek legal advice where required to protect levy investment on the development of new varieties, and to deliver new varieties for all growers.

MASTERS PROJECT PROPOSAL
MODERN BREEDING TOOLS FOR RAPID VARIETY DEVELOPMENT

Where possible, modern plant breeding utilises inbreeding (or selfing) to generate 'fixed lines' which are true-breeding (genetically uniform) from seed. These true-breeding lines can then either serve directly as varieties (so-called "inbreds"), or as parents to generate uniform heterozygous F1 offspring (so called "hybrids").

The latter system has been used with great success in a number of commercial crops, for example in maize and tomatoes.

Both true-breeding inbred lines and their hybrid offspring, have the advantage of a genetic uniformity that can be generated at scale and maintained over generations (in perpetuity). This is of particular importance for non-perennial crops of annual or bi-annual life cycle.

Fixing a population from an initial cross typically takes 5-6 generations and generally constitutes a significant investment of time and resources in breeding programs. Genetic gains in any breeding system are a function of time (and cost) and consequently rapid generation advancement (RGA) is an effective means to improve the efficiencies of breeding programs.

In Australian Passionfruit, rootstock and Panama types have undergone some inbreeding (whether by design or accident is unknown), before they are selected for use. Currently materials for inbreeding are grown under field conditions and produce only one generation per year. It thus takes quite a few years to generate new inbreds that can be tested against current true-breeding lines (e.g. Pandora).

For the generation of Purple/edulis -types, however, inbreeding is currently completely by-passed. Heterozygous elite parents are typically crossed, and the resulting heterozygous and segregating offspring are screened directly to identify lines of improved performance. Since these lines can neither be re-generated from parental crosses (as in true hybrids), nor selfing (as in true inbreds), they have to be maintained by vegetative propagation. Cuttings ('tips') are taken from mother vines and grafted onto suitable rootstocks, which over time has reportedly led to problems of varietal decline (e.g. small fruit size, scion tips unsuitable for grafting and blind tipping).

There is scope to adapt Purple/edulis -type breeding to either a true-breeding hybrid system where fixed parental lines are used to generate uniform heterozygous materials, or to select inbred lines in their own right as new 'perpetual' varieties, grown from seed like Pandora.

Consequently, both the Panama system and the Purple/edulis breeding system would benefit from a rapid generation advancement (RGA) protocol, which allows a cost and time efficient cycling of self-pollinations to generate true-breeding materials. This time saving would be achieved by trying to create two or three generations in a single year instead of just one.

Some additional benefits of such a system could potentially be the:

- Regeneration of "look-alikes" of old cultivars e.g. Sweetheart with similar genetic makeup but rejuvenated. The beauty of this system would be the generation in perpetuity of any successful cross
- Establishment of a true-hybrid system with fixed parental lines. A lot of test crosses can then be generated and assessed quickly as only a few of the virtually uniform progeny need be included in assessment and then only once because all progeny will be genetically identical
- Rapid production of new fixed rootstock and Panama lines
- Facilitation of genetic resource management

PROJECT AIM:

The aim of this MSc project is the improvement of the National Passionfruit Breeding Program through establishment of cost and time efficient procedures for the establishment of true-breeding materials and the conservation and possible rejuvenation of non-true breeding materials.

PROJECT OBJECTIVES:

1. Existing Literature Review

Thorough review of the existing literature concerning rapid cycling /breeding and tissue culture. Focus on:

- Growing of vines under space constraints in semi-controlled environments
- Manipulation of flowering time and fruit production using agronomic and chemical intervention
- Selfing and inbreeding depression in semi self-incompatible systems
- Tissue culture for embryo rescue

2. Development of a polytunnel and/or glasshouse-based rapid generation advancement system for passionfruit breeding

In order to move from an annual generation advancement cycle under field conditions to a cycle that allows for multiple cycles per year under semi-controlled conditions the Master's candidate will design and carry out a range of growth and self-pollination trials. Specifically, the candidate will use a number of populations at different levels of genetic fixation to:

- Test different growth media and irrigation/fertigation systems to avoid root pathogens and minimise space requirements
- Test different trellis systems to allow growth in confined spaces
- Test different pruning systems to reduce plant size and induce early flowering
- Test different chemical interventions to induce early flowering
- Test different photo-period regimes to see if flowering can be stimulated early
- Test different self-pollination and crossing systems (while tracing self-incompatibility), and establish pollen preservation methods
- Test viability of seed from unripe fruit and establish tissue culture conditions to germinate seeds which are not fully developed (embryo rescue)
- Test different marker systems to efficiently monitor rates of remnant heterozygosity and establish genetic fingerprints

PROJECT OUTPUT & OUTCOME:

A set of standard operating procedures (SOPs) that enable the generation of true breeding materials for trialling at significantly reduced time and cost.

This system will generate opportunity for early selection for traits that can be screened either phenotypically in controlled environments (e.g. disease screens using inoculum) or genotypically using molecular markers. This would allow for a drastic reduction of lines to be tested in the field, cutting down on trialling costs at later stages.

HOW CAN WE FUND THIS?

This project cannot be funded by existing levy money as there are no levy funds available until after 1 July 2020.

SCU have proposed a joint funding arrangement between Passionfruit Australia Inc and SCU.

We firmly believe that this project represents an important set of benefits for the future of the passionfruit industry and PAI are seeking contributions to assist with the funding of our share of the student stipend which is $21,000 for an 18-month project period.

If you'd like to know more about this exciting project proposal, please contact:

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LABOUR NEWS: A HARVEST TRAIL BUILT ON FAIRNESS

The Fair Work Ombudsman (FWO) Inquiry into workplaces along Australia's Harvest Trail found widespread non-compliance, with inspectors recovering more than $1 million in unpaid wages for over 2,500 workers.

During the inquiry, the FWO took court action against eight employers for serious alleged breaches of the Fair Work Act, with four actions involving labour hire contractors. Six matters have now been finalised resulting in over $500,000 in penalties, and two remain before court.

Fair Work Inspectors also issued 150 formal cautions to employers, 132 infringement notices and 13 compliance notices for breaches of workplace laws during the inquiry and entered into seven Enforceable Undertakings.

As part of the inquiry, inspectors investigated 638 businesses connected with the harvesting of various crops including citrus, grapes, strawberries, cherries, mushrooms, apples and tomatoes. There were 444 growers and 194 labour hire contractors investigated.

Since the report was published in November 2018, the FWO has established a stakeholder reference group to consider crucial next steps to implement the recommendations outlined in the inquiry report and help build a culture of compliance. The first meeting of the reference group took place in Melbourne on the 5th March. The purpose was to ensure a shared understanding of the issues within the group and set out a plan for taking the recommendations from the enquiry and implementing them across the horticulture sector.

If you have any queries at all about how to correctly pay your workers, there is plenty of assistance available. Ignorance is not an excuse for non-compliance.

Useful resources:

https://www.fairwork.gov.au/find-help-for/horticulture#employers

https://calculate.fairwork.gov.au/findyouraward