Australian Strawberry Breeding Program Update

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This article provides a Subtropical and Mediterranean seasons wrap-up and activity update for the project BS22000: Australian Strawberry Breeding Program

The Australian Strawberry Breeding Program (ASBP) has made steady progress in adapting strawberry varieties for Australia's different climates. Our recent activities aim to benefit growers and industry by producing varieties with increased yields, larger fruit sizes, and resilience to diseases, while also meeting consumer demand for taste and visual appeal.

Breeding program overview

The ASBP works to develop new strawberry varieties adapted to Australia's three growing climates: temperate, subtropical, and Mediterranean. The new varieties must have superior production traits for grower profitability, and excellent quality to drive repeat purchases in consumers.

Our breeding program pipeline consists of four stages of trialling: seedlings, early-stage clones, advanced-stage clones, and on-farm trials. These are summarised in Figure 1. Every year we choose specific combinations of parents for each region to cross-pollinate and create thousands of seedlings. These seedlings, each one genetically unique, are visually assessed at multiple times through the season in seedling trials. The seedlings that display desirable fruit and plant architecture characteristics throughout the season are dug from the ground and clonally propagated. These accessions are then planted in replicated 'early-stage' clonal trials the following year.

Accessions in the early-stage trials are harvested and assessed weekly for yield, average fruit size, flavour, firmness and many other traits. Our breeders use quantitative genetics analyses to select the best performing lines for further evaluation in 'advanced-stage' trials. Comprehensive evaluations are again conducted weekly, with elite material supplied to fruit growers for 'on-farm' trials. Feedback and data from the growers at this stage is extremely valuable and helps in the decision making of whether any are selected for commercialisation. These four trial stages are conducted concurrently each year in each production region.

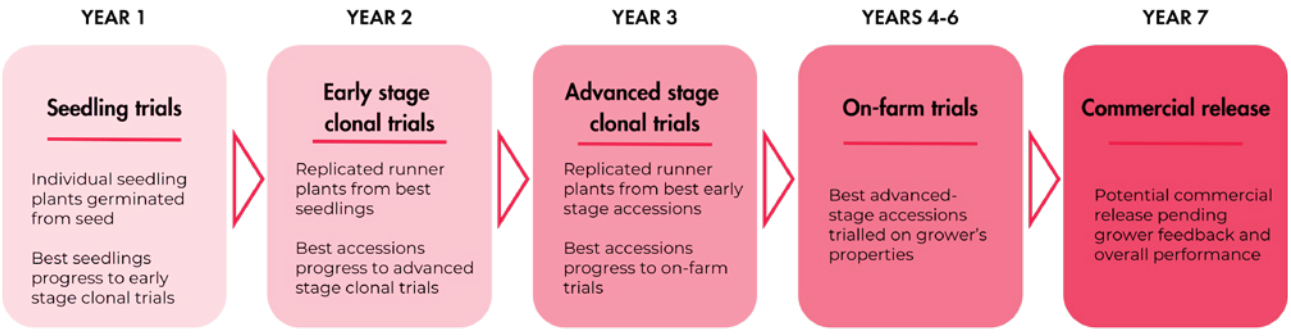

Figure 1. ASBP breeding pipeline showing trial stages. These trials are run every year in each region.

Subtropical and Mediterranean seasons wrapped up

For the subtropical region, our seedling and clonal trials wrapped up in early September. We selected 113 seedlings from across our two sites in Bundaberg and Nambour (Figures 2 and 3). These included nine from genomics analyses (more detail below) and 6 from crosses between white and very dark red accessions, which has successfully carried across the enhanced flavour of our novelty white and blush fruit into standard and dark red fruit. We have also selected 19 early-stage and 21 advanced-stage accessions, chosen through statistical analysis of multi-year trial data and invaluable feedback from industry partners involved in our on-farm trial programs.

These on-farm trials, which involved six accessions across four locations and provided industry-led insights, have played a critical role in guiding our selection process for the future.

Our Mediterranean trials have now also concluded, with 92 seedlings selected, and seven early-stage and six advanced-stage accessions from a trial in Bullsbrook, WA. Four of the seedling accessions were from genomics analyses, and ten specifically bred for tolerance to *Fusarium* wilt. We were very pleased to hear that the new subtropical variety '*Stella*' has performed well across the board in South-East Queensland in 2024.

Industry engagement

Progress of our breeding trials has been communicated to growers and industry representatives in multiple settings, including field days, reference group meetings and grower meetings. One such event held at a grower's farm in Wanneroo (WA) provided a closer look at accessions from the Mediterranean clonal trial and allowed for feedback on accession performance (Figure 4). Similarly, a temperate farm walk was held at the Wandin Research Centre in December, where valuable feedback on advanced accessions was provided by industry members. Comprehensive end-of-season reports were developed for each region and distributed to growers and industry members.

Temperate season is ongoing

The temperate region's trials at Wandin, Victoria involve a seedling trial of 13,000 genotypes from 53 families, and a clonal trial of 76 early-stage and 26 advanced-stage accessions. Data collection in the temperate clonal trial will continue to the end of April again, as requested by our Temperate Reference Committee. Temperate on-farm trial plants were distributed to six growers across five states over winter, in line with their local planting schedules.

Genomics analyses

Genomics analysis is a way to study an organism's DNA, which includes all of its genes, to understand its characteristics, how it functions and what we can see in the organism. In plant breeding, we can use genomics to help to identify patterns in the DNA that code for different traits like large fruit size and flavour through the use of statistical analyses. Genomics is particularly useful to help to increase breeding efficiency and develop better selections. This is because we can examine the DNA of plants that have not yet been assessed (those for which we have no trait performance data) and predict their performance based on the DNA patterns.

We have now used genomics analyses to predict the performance of individuals based on their genetic data. Six subtropical, four Mediterranean and five temperate 2023 seedling accessions were predicted to have high performance for multiple traits. These were included in crosses with complementary accessions and will be assessed in seedling trials in 2025. In this way, we are progressing elite genetics through our breeding pipeline a year earlier than is possible without the use of genomics.

Disease screening

Disease resistance continues to be a priority area for the ASBP, with multiple screening trials progressing each year and tolerant accessions being used in cross-pollinations.

Powdery mildew resistance screening took place from May to September 2024. Accessions assessed included over 300 seedlings from nine temperate and 16 subtropical families, as well as two Mediterranean, 11 temperate and nine subtropical clones. Each year, we continue to select more seedlings with tolerance to powdery mildew as well as good plant architecture, large fruit size and firmer fruit.

Figure 2. Breeder Dr Jodi Neal making final selections at the 2024 seedling trial at Bundaberg, Queensland
Photo credit: Department of Primary Industries, Queensland

Figure 3. Breeder Dr Katie O'Connor assessing the 2024 seedling trial at Nambour, Queensland
Photo credit: Department of Primary Industries, Queensland

Figure 4. Dr Jodi Neal presenting to industry at the field day in Wanneroo, Western Australia
Photo credit: Helen Newman

A *Fusarium* wilt resistance screening trial on seven temperate, 13 subtropical and four Mediterranean accessions commenced in June 2024 and concluded in early December. Screening for resistance to charcoal rot (*Macrophomina phaseolina*) commenced in August 2024 and included 12 subtropical and 11 temperate accessions. It will be concluded in late January 2025, at which time anthracnose crown rot (*Colletotrichum gloeosporioides*) screening will commence.

Conclusions

Going forward, we maintain our commitment to delivering results that will positively impact the strawberry farming industry. Our team is always here to discuss any aspect of our work or to receive feedback, which is vital for the success and relevance of our breeding efforts.

Acknowledgements

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We are also extremely grateful to all the fruit producers in all states who have trialled, collected data on, and given feedback on our on-farm accessions. This has helped us make more informed and better commercial judgments.

The Australian Strawberry Breeding Program team members include Jodi Neal (project lead), Michaela Antoine (Perth field assistant), Freya Brinkley (Nambour lab assistant), Mitchell Gates (Nambour lab assistant), Joanna Gillespie (genetics and virus indexing), Dilmini Hettiarachchi (PhD student), Lilian Kass (Nambour field assistant), Dale McKenna (Nambour field technical officer and hydroponics), Alan Noon (Wandin field assistant), Katie O'Connor (breeding and genomics), Michelle Paynter (virus indexing, tissue culture, and pathology), Melanie Ritter (Wandin field assistant), Karen Spencer (Wandin operations manager), and Louella Woolcock (Nambour field and glasshouse operations manager).