Horticulture Innovation Australia

Final Report

Evaluating dried grapes types for the Australian industry

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DG12004

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Summary

The project was designed to provide a direct benefit to the Australian dried vine fruits industry. It aimed to build on the previous CSIRO breeding projects and continue the evaluation of breeding lines to develop improved drying varieties with potential to enable the industry to meet future challenges associated with production in a variable and changing climate and overcome problems/deficiencies of existing standard varieties. A focus of the study was the identification of alternative Sultana types, to overcome significant issues with the dominant variety, Sultana. These issues include production and quality losses associated with rain damage at harvest, the development of mouldy fruit and inconsistent production due to variable fruitfulness and biennial bearing.

Material under evaluation, established by CSIRO in their previous project (DG 04003), included 1700 single vine seedlings, 360 promising selections which had been propagated in multiplied plots and 7 promising selections established on a grower site, for assessment under semi commercial conditions and to provide sufficient fruit for processing and test marketing. Prior to harvest visual inspections were undertaken in the field to identify selections for culling based on low fruitfulness and yield potential, development of significant seed traces or seeds, poor berry size uniformity and flower sex, avoiding female types. Further selections were identified for culling after evaluation of the dried grape samples. Key criteria used in the culling process were low yield potential, maturity date (discarding late ripening types), rain intolerance (discarding types with damaged berries showing obvious splitting), lack of berry size uniformity, poor colour (discarding selections with dark dried fruit unsuitable for sultana like products), poor colour uniformity, sensitivity to berry damage during harvesting and processing, presence of a significant lignified seed trace, lack of berry 'plumpness', poor visual characteristics of the skin surface and poor sensory attributes (texture and flavour). Over the course of the project, significant culling based on the above criteria was undertaken with numbers reduced to approximately 200 seedlings and 150 multiplied selections.

A total of 36 selections for the production of light coloured sultana like products, covering a spectrum of harvest dates, which have met the key criteria with respect to rain tolerance, dried grape quality attributes and yield potential have been identified. Four of these selections have been targeted for evaluation under semi-commercial conditions on grower properties and inclusion in a Plant Breeders Rights (PBR) comparator trial to establish distinctness, uniformity and stability. A further 13 larger berried selections have also been identified with potential to extend the product range of light types available. Release of one or more of these selections as varieties for industry adoption will enable growers to not only achieve high fruit quality and productivity, but minimize risks associated with rain damage and poor drying conditions associated with unfavourable climatic events.

In addition, 16 small berried types suited to light coloured dried grape production and 13 black selections covering a range in berry size, ranging from small currant types up to the size of raisins, have been selected. These will be retained by CSIRO for future research purposes and be available for industry adoption if there is increased market demand for such products.

Keywords

dried grapes, raisins, sultanas, currants, rain tolerance, light colour, evaluation, semi-commercial, yield potential, maturity date, berry weight.

Introduction

The Australian dried grape industry continues to face new and evolving challenges surrounding production in a changing and variable climate, limited water supply and increasing consumer and regulatory demands with respect to product integrity and environmental responsibility. Hence there is a need for productive seedless drying types that are consistently fruitful and regularly produce high yields of high quality dried grapes, particularly in a water limited environment, have berries that do not split in wet harvest seasons, and deliver consumers fruit with desired taste and flavour characteristics and with the knowledge that production has occurred in an environmentally responsible manner.

Over the years, CSIRO Agriculture maintained a vine improvement program to provide the viticultural industries with material suited to Australian conditions and industry needs. New seedless drying varieties have been bred or imported and maintained in the CSIRO germplasm collection. Varieties released for dried fruit production from this breeding program have included Carina (1975), Merbein Seedless (1981), Marroo Seedless (1988), Sunmuscat (1997), Shirana (2003) and more recently, Black Gem & Sunglo (2010) and FSAC Bruce's Sport (2014). Previous CSIRO dried grape breeding projects, developed with input from HIA and in consultation with industry, generated significant seedless germplasm with potential for industry adoption as new varieties. Key objectives of the CSIRO studies had been development of new varieties:-

1. with high water use efficiency, based on short seasonality, high fruit to leaf ratios and high productivity to address the issue of limited water supply,
2. with rain tolerance to minimise production and quality losses and to reduce or eliminate potential for mould and Ochratoxin A development,
3. for product differentiation and/or niche marketing,
4. with disease resistance to reduce the use of chemicals for fungal control and suited to other market categories, e.g. organics.

This project, through Dried Fruits Australia in consultation with CSIRO, will enable the Australian Dried Grape Industry to continue the evaluation of material generated in previous projects, particularly material from DG04003 (development of rain tolerant drying types) and DG09000 (Enhanced dried grapes types for the Australian industry). Material for evaluation, included single vine seedlings, promising selections which had been propagated in multiplied plots or top-worked/grafted onto existing material and a small number established on a grower site, for assessment under semi-commercial conditions and to provide sufficient fruit for processing and test marketing. While material across all categories of dried grape products was assessed (i.e. sultanas, currants and raisins) a focus of the study was the identification of alternative Sultana types, to overcome significant issues with the dominant variety, Sultana. These issues include production and quality losses associated with rain damage at harvest, the development of mouldy fruit and inconsistent production due to variable fruitfulness and biennial bearing.

A project management Committee which included representation from DFA, CSIRO and growers provided guidance to the conduct of the project. The broader based, Unique Australian Dried Grape Varieties Steering Committee formed for earlier CSIRO projects, continued to provide strategic guidance to the project to ensure consistency with industry needs, to identify selections with most potential and to facilitate their commercial adoption. Members of this committee include representatives from all industry sectors (growers, processors and marketers), HIA and CSIRO.

Methodology

This project, enabled the Australian industry through Dried fruits Australia, in consultation with CSIRO, to continue the evaluation of material generated from breeding studies in previous projects. Material evaluated in the study included:-

- Seedling populations developed in the previous project, from seedless by seedless crosses or crosses aimed at introduction of disease resistance genes. At the commencement of the project there were about 1700 genotypes in this category. They were established on single wire trellis with a 3.0 x 1.8m, row x vine configuration.
- Selections of promising types identified in seedling populations established in multiplication plots in the field. At the commencement of the project there were about 360 advanced selections in this category. These included selections established on own roots or grafted/top worked onto high vigour rootstocks, Ramsey and 1103 Paulsen. They were established on T-trellis or a modern Swing-arm trellis with a 3.0 x 1.2 m, row x vine configuration.
- Seven light coloured selections established for semi-commercial evaluation on a grower site, grafted on 1103 Paulsen and Ramsey (ie. 50 vines of each) and managed on a modern Swing-arm trellis. The selections included three rain tolerant Sultana types established by top-working in spring 2011, a USDA muscat selection which was top-worked in spring 2010, and 3 genotypes established in the earlier project, DG04003 (i.e. a high yielding CSIRO selection, a USDA selection which appears to have tolerance to downy mildew, and Canner Seedless).
- Remnant 200 single vine seedling material transferred from the CSIRO Merbein site which included *in-ovulo* embryo rescue material, yet to be evaluated, some disease resistant material and parents of breeding lines, retained for PBR purposes.

Specific tasks undertaken during the evaluation project included:-

- Pruning of seedling and multiplied lines,
- Collection of dormant cutting material of promising selections for establishment in multiplied plots or semi-commercial sites,
- Vine training, grafting and top-working where required,
- Assessment of fruitfulness to facilitate management and identify yield potential,
- Collection and processing of berry samples to monitor fruit maturation and identify the optimum time of harvest or cane cutting where trellis drying was imposed,
- Harvest evaluation of fruit characteristics,
- Rack & trellis drying of promising selections. Except for the black selections which were dried as naturals, drying included application of drying emulsion with the aim to produce light coloured products,
- Cleaning and assessment of dried grape samples,
- Identification of poor performing selections based on productivity and dried grape quality for culling (see below),
- Conduct of field walks with the Project Management Committee and members of the Unique Australian Dried Grape Varieties Steering Committee,
- Liaison with CSIRO regarding farm management and use of facilities at the Irymple site,
- Liaison with CSIRO with respect to data base management, intellectual property issues, coordination of steering committee meetings, culling of material and next phase development of potential selections by semi-commercial growers, with appropriate agreements in place,
- Liaison with CSIRO in regard to establishment of comparator trials for Plant Breeders Rights purposes to determine distinctness, uniformity and stability of the most advanced selections
- Coordination of the Project Management Committee and the Unique Australian Dried Grape Varieties Steering Committee meetings.

Prior to harvest visual inspections were undertaken in the field to identify selections for culling based on low fruitfulness and yield potential, development of significant seed traces or seeds, poor berry size uniformity and flower sex, avoiding female types. Further selections were identified for culling after evaluation of the dried grape samples. Key criteria used in this culling process were low yield potential, maturity date (discarding late ripening types), rain intolerance (discarding types with damaged berries showing obvious splitting), poor berry size uniformity, poor colour (discarding selections with dark dried fruit unsuitable for sultana like products), poor colour uniformity, susceptibility to berry damage during harvesting and processing, presence of a significant lignified seed trace, lack of berry 'plumpness', poor visual characteristics of the skin surface and poor sensory attributes (texture and flavour).

Outputs

1. Drying conditions.

A major focus of the CSIRO dried grape breeding and evaluation program has been aimed at the development of rain tolerant Sultana types. Drying conditions experienced over the course of the 3 drying seasons in 2013, 2014 and 2015 provided significant opportunities to assess selections for their rain tolerance (Table 1.1). In season 2013, there was a significant rainfall event on the 27th - 28th February which, not only allowed the rain tolerance of late ripening selections to be assessed, but also provided an opportunity to assess darkening of early ripening light type selections which were at the later stages of the drying process. The significant rainfall event on the 28th of March would also have caused darkening of later ripening selections. Climate conditions during the 2014 season led to very difficult drying conditions over the entire drying period. The very significant rainfall event which occurred 14th -15th February provided an opportunity to assess rain tolerance of most selections. The significant rainfall events on the 28th of March and the 10th - 11th April together with the persistent lighter showers occurring over the drying season caused delayed drying and darkening of most samples. In contrast, in season 2015, early rainfall events on the 9th - 13th of January produced significant splitting in many of the early ripening and mid-season varieties, including the benchmark variety, Sultana. However, drying conditions during the main drying period in February and March were excellent which allowed the potential for the production of light type fruit to be assessed.

Table 1.1. Summary of rainfall events and relative humidity (RH) recorded at 9.00 am on the days rainfall occurred during the drying period (January to April) in 2013, 2014 and 2015.

2013			2014			2015		
Date	**Rainfall (mm)**	**RH (%)**	**Date**	**Rainfall (mm)**	**RH (%)**	**Date**	**Rainfall (mm)**	**RH (%)**
14-Jan	1.2	63	3-Jan	0.2	67	4-Jan	4.0	69
14-Feb	0.8	70	24-Jan	0.4	64	9-Jan	15.0	89
20-Feb	0.2	54	14-Feb	16.0	97	10-Jan	15.6	100
23-Feb	0.2	42	15-Feb	49.0	96	11-Jan	6.0	82
27-Feb	4.4	78	20-Feb	2.0	66	13-Jan	16.4	97
28-Feb	9.0	73	12-Mar	2.2	84	14-Feb	0.6	50
28-Mar	10.4	93	15-Mar	1.0	89	7-Apr	4.6	92
31-Mar	0.4	93	16-Mar	2.0	72	17-Apr	17.4	97
22-Apr	2.8	84	26-Mar	0.2	84	18-Apr	60.0	95
29-Apr	1.4	92	27-Mar	23.6	95	19-Apr	0.8	70
30-Apr	2.0	83	28-Mar	0.2	86	25-Apr	9.0	93
			3-Apr	3.8	88	26-Apr	1.2	78
			9-Apr	3.2	93			
			10-Apr	20.6	98			
			11-Apr	15.4	85			
			26-Apr	0.2	63			
			27-Apr	0.2	58			
			30-Apr	14.2	84			

2. Overview of the evaluations conducted in each season

Each season fruit from the most promising seedling vines and multiplied selections, including those grafted on Ramsey or 1103 Paulsen were either rack dried after hand harvesting or trellis dried in situ and the dried samples evaluated. Each year the number of selections available for assessment varied as the more recent plantings of seedlings and multiplied selections commenced production and poor performing vines were culled from the vineyard as described in the methods above.

In season 2013, a total of 127 single vine seedlings and 173 multiplied selections were harvested and dried for future assessment. The seedling material was hand harvested and rack dried on a neighbouring grower's property. Trellis drying was used for 58 of the multiplied selections. The rest were rack dried. The seedling plantings were assessed with 400 identified as being unsuitable and culled. Light type fruit samples available for evaluation included 109 singles and 151 multiplied selections of varying berry sizes. Of these, 42 multiplied and 11 seedling selections were identified for culling. Also, dried samples evaluated included 18 black seedlings and 22 black multiplied selections. After evaluation of the dried samples, 3 seedlings and 2 multiplied selections were identified for culling.

As indicated above, the 2014 drying season proved to be a very difficult season due to frequent rain events leading to crop losses and impacts on harvest and drying. In total, 306 selections were harvested and dried. These included 129 single vine seedlings, 80 multiplied selections, which were rack dried, and 97 selections which were trellis dried. These included 25 currant types, 38 larger black seedless types, 80 small light types, 122 sultana types and 40 larger seedless types with potential as raisins. With regard to harvest date, 15%, 37% and 48% were harvested (or cut for trellis drying) in January, February and March respectively. Of the black selections, 8 single vine seedlings and 11 multiplied selections were identified for culling. Of the light coloured selections, 28 seedling selections and 14 multiplied selections were identified for culling. In total 200 single vine seedlings with undesirable traits were identified for culling in winter 2014. Two of the earlier ripening selections which produced light coloured fruit were identified with potential and recommended for inclusion in PBR, DUS trials (see details below).

As indicated above, drying conditions in the 2015 season were excellent, except for a significant rainfall event prior to harvest in early January which caused some splitting, leading to losses in commercial Sultana plantings. This event enabled rain tolerance of early ripening selections to be assessed, leading to a number being identified for culling prior to harvest. In total 200 selections (160 light sultana and 40 black types) were dried. Approximately 150 of these were trellis dried in multiplied plots. Of the black types, 12 single vine seedlings and 7 multiplied selections were identified for culling after evaluation of the dried samples. Light coloured selections dried in 2015 included 33 small berried selections, of which 4 with significant potential were identified for retention, 12 were identified for further evaluation with 17 identified for culling. In total, 26 large berried light types were dried of which 3 were identified with significant potential for retention, 14 were identified for further evaluation with 9 identified for culling. The sultana 'type' category included samples from 59 seedlings and 71 multiplied selections. Based on the assessments, 6 single vine and 9 multiplied selections were identified with significant potential for retention, 40 single vine and 29 multiplied selections were identified for further evaluation, while 13 singles and 36 multiplied selections were identified for culling. Two of these selections which produced light coloured fruit were identified with significant potential and recommended for inclusion in PBR, DUS trials (see details below).

3. Selection of Sultana types

The major focus of the project has been the identification of rain tolerant types for the production of light coloured sultanas, particularly those which ripen earlier than the rain tolerant, Sunglo and Sunmuscat varieties. After assessment of the dried grape samples produced in 2015, using the criteria provided above, and also taking into account yield potential and time of maturity, 9 high priority selections have been identified. Data available for harvest date, berry weight, total soluble solids and yield potential are provided for these selections and Sultana in Table 3.1. They include the 4 selections identified with industry input (see below) for inclusion in a PBR/DUS comparator trial. Despite the early ripening of these selections, none had significant rain damage and produced a light coloured sultana like product (Figure 3.1). When dried under the same conditions, Sultana displayed significant rain damage from the rainfall events in January leading to a high proportion of dark berries (Figure 3.1). Despite the relatively early harvest dates (6th - 25th February), all selections had adequate levels of maturity (i.e. 21.6 - 27 ^{o}Brix). The high levels of total soluble solids of the earliest ripening selections, ST1, ST2, ST3 and ST4, indicate that they could possibly have been harvested even earlier, around the end of January. It is interesting to note that the earlier selections tended to produce redder, less light fruit than the later selections which may possibly be associated with higher temperatures during drying.

Table 3.1. Developmental stage, date of cane cutting or hand harvest, fresh berry weight, juice total soluble solids (TSS) and calculated fresh yield of high priority selections which produced high quality dried grape samples with sultana like characteristics in season 2015. Sultana data are included for comparative purposes.

Selection	Development stage	Date (cut/harvest)	Berry weight (g)	TSS (^{o}Brix)	Yield (kg/vine)
Sultana H5	Multiplied	20th Feb.	2.13	23.6	6.7
ST 1	Multiplied	6th Feb.^{1}	1.76	26.4	9.6
ST 2	Multiplied	6th Feb.^{1}	1.71	27.0	12.4
ST3	Multiplied	9th Feb.^{2}	1.77	24.7	8.8
ST4*	Multiplied	10th Feb.^{1}	1.64	25.2	12.3
ST5*	Single	17th Feb.^{1}	2.11	22.1	22.0
ST6*	Multiplied	18th Feb.^{2}	1.78	23.1	17.3
ST7*	Single	19th Feb.^{3}	2.78	21.6	12.0
ST8	Single	23rd Feb.^{1}	1.77	22.1	9.8
ST9	Single	25th Feb.^{2}	2.48	24.0	9.1

***** indicates selections identified for inclusion in PBR, DUS trials
^{1,2,3} Superscript indicates the number of seasons data that were available and included.

Sultana

ST2

ST4

ST5

ST6

ST8

ST9

ST10

Figure 3.1. Views of dried Sultana and a number of the high priority selections selected in 2015 showing uniformity of colour and berry size. Note all samples were collected from own rooted vines.

A further 27 rain tolerant selections were also identified with potential to produce a quality light coloured, sultana like product in season 2015. Data on these selections, together with Sultana, are provided in Table 3.2. Harvest dates for these selections ranged from the 5th of February to 13th March. With the exception of 3 selections (ST26, ST33 and ST37 grafted on Ramsey rootstock), most had excellent levels of maturity at harvest. In general, yield potential of these selections was higher than the high priority selections described above (Table 3.1). The high yield of ST37 grafted on Ramsey rootstock provides an indication of the yield potential of selections when grafted on high vigour rootstocks. Despite the high yield and low maturity level at harvest this selection still produced light coloured fruit of acceptable quality (Figure 3.2).

Sultana | ST15 | ST17

ST21 | ST29 | ST37 (Ramsey)

Figure 3.1. Views of dried Sultana and a number of the selections identified in 2015 as promising light coloured Sultana types. Note all samples were collected from own rooted vines except for MS 46-20.

Table 3.2. Date of cane cutting or hand harvest, fresh berry weight, juice total soluble solids (TSS) and calculated fresh yield of promising selections which produced high quality dried grape samples with sultana like characteristics in season 2015. Sultana data are included for comparative purposes.

Selection	Date (cut/harvest)	Berry weight (g)	TSS (°Brix)	Yield (kg/vine)
Sultana H5	20th Feb.	2.13	23.6	6.7
ST11	5th Feb.[1]	1.55	25.1	13.3
ST12	5th Feb.[1]	2.66	22.2	15.2
ST13	10th Feb.[1]	2.36	23.9	19.2
ST14	11th Feb.[1]	2.18	23.7	19.8
ST15	11th Feb.[1]	1.57	23.6	17.8
ST16	11th Feb.[1]	1.94	22.5	14.7
ST17	12th Feb.[1]	1.95	25.1	21.0
ST18	17th Feb.[1]	1.66	22.7	28.7
ST19	17th Feb.[1]	2.08	22.7	10.4
ST20	27th Feb.[1]	1.46	23.7	13.6
ST21	28th Feb.[2]	2.96	23.5	17.1
ST22	2nd Mar.[1]	1.11	25.2	11.6
ST23	3rd Mar. [2]	1.43	22.0	16.6
ST24	4th Mar. [2]	1.47	24.2	17.9
ST25	8th Mar. [2]	1.94	25.3	12.9
ST26	8th Mar. [2]	1.89	19.6	19.7
ST27	10th Mar.[1]	1.75	23.0	12.7
ST28	10th Mar.[1]	2.74	24.1	13.2
ST29	10th Mar.[1]	2.25	23.9	16.8
ST30	10th Mar.[1]	1.55	23.2	12.4
ST31	11th Mar.[1]	1.69	21.3	14.0
ST32	11th Mar.[1]	1.04	26.4	20.8
ST33	11th Mar.[1]	2.27	18.6	30.2
ST34	12th Mar. [3]	2.77	23.1	13.2
ST35	12th Mar.[3]	2.28	24.0	16.4
ST36	12th Mar.[3]	1.97	24.3	15.9
ST 37 (Ramsey)	13th Mar.[2]	1.56	18.5	62.5

[1,2,3] Superscript indicates the number of seasons data that were available and included.

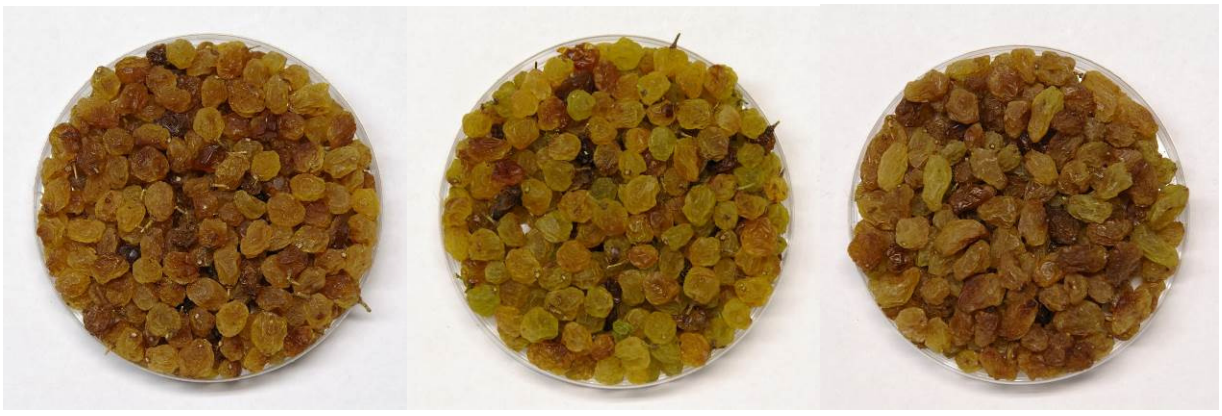
4. Small berried selections for light fruit production

A target of earlier CSIRO breeding was the development of small berried types to produce a light coloured product, targeted at specialty markets in Europe. Over the course of the project a number of the small berried selections were dried and evaluated. Based on advice from industry, there is now little demand for such products. As a consequence, the industry has advised, through the Project Management Committee and the Unique Australian Dried Grape Varieties Steering Committee, that the best selections should be 'parked' and retained as a future resource at the CSIRO Irymple site. Following the assessment of the 2015 fruit, 4 selections have been identified for retention based on their rain tolerance, fruit quality and yield potential with the relevant data presented in Table 4.1. All 4 selections achieved adequate levels of maturity at harvest which ranged from the 5th - 28th of February. A further 14 of these selections were identified for further evaluation with examples of the products displayed in Figure 4.1.

Table 4.1. Date of cane cutting or hand harvest, fresh berry weight, juice total soluble solids (TSS) and calculated fresh yield of the best small berried selections which produced high quality dried grape samples in season 2015.

Selection	Mean Date (cut/harvest)	Mean Berry wt. (g)	TSS (°Brix)	Yield (kg/vine)
SB1	5th Feb. [3]	1.040	22.4	26.0
SB2	12th Feb. [1]	0.890	24.4	14.9
SB3	12th Feb. [3]	0.940	23.1	20.4
SB4	28th Feb. [2]	0.723	25.0	21.0

[1,2,3] Superscript indicates the number of seasons data that were available and included.



SB5 SB6 SB7

Figure 4.1. Examples of dried products produced from small berried types after emulsion treatment. ote all samples were collected from own rooted vines.

5. Large berried selections for light fruit production

A target of the CSIRO breeding had been the development of large berried seedless types as alternatives to the standard varieties, Muscat Gordo Blanco and Waltham Cross. Following the evaluation of the 2015 dried grape samples 3 selections with high potential have been identified, with a further 14 identified for further assessment. A number of these selections have muscat flavor. Harvest data for the 3 high priority selections is presented in Table 5.1. They achieved adequate levels of maturity at harvest which ranged from the 16th of February to the 6th of March and displayed high yield potential. All three selections produced excellent uniform light coloured products (Figure 5.1.). It should be noted that the selection M 44-14® has been released by CSIRO as a mid to late season, table grape. Examples of the products from selections identified for further evaluation are displayed in Figure 5.1.

Table 5.1. Date of cane cutting or hand harvest, fresh berry weight, juice total soluble solids (TSS) and calculated fresh yield of the best large berried selections which produced high quality dried grape samples in season 2015.

Selection	Mean Date (cut/harvest)	Mean Berry wt. (g)	TSS (°Brix)	Yield (kg/vine)
LB1	16th Feb. [3]	2.983	23.5	17.1
LB2	11th Mar. [1]	3.892	21.3	26.0
M 44-14®	6th Mar. [3]	4.009	24.1	31.3

[1,2,3] Superscript indicates the number of seasons data that were available and included.

LB3 LB4 LB5

Figure 5.1. Examples of dried products produced from large berried types after emulsion treatment. Note all samples were collected from own rooted vines.

6. Black berried selections for drying as naturals

A target of the CSIRO breeding had been the development of self-pollinating, early ripening, black currant types as alternatives to Carina currant which requires setting sprays for fruit set and has reasonably late maturity. Over the course of the project a number of the small black selections were dried and evaluated. Examples of the currant like products are provided in Figure 6.1. Based on advice from industry, there is now little demand for currants. As a consequence, the industry has advised, through the Project Management Committee and the Unique Australian Dried Grape Varieties Steering Committee, that the best selections should be 'parked' and retained as a future resource at the CSIRO Irymple site. Also, a number of black seedless selections with larger berries which produce interesting products that may have niche market potential have also been evaluated. A summary of the harvest data for the best black selections harvested from either multiplied blocks and single vines is provided in Table 6.1. Harvest dates ranged from 4th February to 17th March. Berry weights ranged from 0.81 to 3.06 g. Most selections had adequate levels of maturity and displayed high yield potential. The high levels of total soluble solids of three of the late harvested selections, BB7, BB11 and BB13 indicate that they could be harvested earlier.

Table 6.1. Date of cane cutting or hand harvest, fresh berry weight, juice total soluble solids (TSS) and calculated fresh yield of the best black selections which produced high quality dried grape samples in season 2015.

Multiplied vine	**Mean Date (cut/harvest)**	**Mean Berry wt. (g)**	**TSS (°Brix)**	**Yield (kg/vine)**
BB1	4th Feb. [1]	0.81	24.3	4.4
BB2	4th Feb. [1]	3.02	21.0	6.6
BB3	6th Feb. [2]	3.06	22.6	26.7
BB4	18th Feb. [1]	1.04	22.9	13.5
BB5	19th Feb. [2]	2.22	19.1	14.4
BB6	20th Feb. [3]	1.65	22.1	17.3
BB7	27th Feb. [1]	2.07	26.1	21.3
BB8	17th Mar. [1]	1.16	23.0	35.2
Single vine				
BB9	4th Feb. [1]	0.76	22.0	16.4
BB10	4th Feb. [1]	1.03	23.0	12.0
BB11	18th Feb. [2]	1.23	21.2	14.1
BB12	18th Feb. [2]	1.34	25.7	12.6
BB13	6th Mar. [1]	1.97	28.3	15.6

[1,2,3] Superscript indicates the number of seasons data that were available and included.

BB1 BB9 BB4

Figure 6.1. Examples of dried products produced from small berried black types. Note all samples were collected from own rooted vines.

7. SEMI-COMMERCIAL EVALUATION

Each year the selections established on the semi-commercial grower site were trellis dried, mechanically harvested and the fruit submitted to commercial evaluation by a commercial processor. Although highly productive, based on feedback from the grower and the commercial processor, the Unique Australian Dried Grape Varieties Steering Committee accepted a recommendation in August 2015 that Canner Seedless and 2 CSIRO selections be removed due to late ripening and in the case of one CSIRO selection, an issue with the development of a 'green tinge' in the dried sample. These selections will be replaced with the most promising Sultana types identified in output 3 (Table 3.2) above, by top-working onto the rootstock in spring 2015.

8. ESTABLISHMENT OF PBR, DUS TRIAL

A replicated PBR trial comparator trial to establish distinctness, uniformity and stability (DUS) was planted in November 2014 with two promising, early ripening selections, with fruit characteristics similar to Sultana, that were identified in season 2013-14. A further 2 selections identified in 2014-15 will be propagated and included in the trial in spring 2015. Details of the 4 CSIRO selections are provided in Table 3.1 above (asterisked Selections). The trial will be maintained and assessed in the shade house at the CSIRO Irymple site. The comparator varieties chosen for the trial include Sultana types grown commercially or with potential for commercial dried grape production in Australia (i.e. DoVine, Fiesta, Merbein Seedless, Selma Pete, Sultana H5 and Sunglo). Field data of key characteristics for the selections and comparator varieties collected in this project will provide further information to support a PBR provisional application.

9. INDUSTRY ENGAGEMENT

The project was overseen by the Unique Australian Dried Grape Varieties Steering Committee with representation from the dried grape industry, HIA and CSIRO (representing CSIRO's IP interest in material under evaluation in the project). A Project Management Committee, with representation from

DFA, CSIRO and growers was also established to provide input into the conduct of the project.

Each season, prior to harvest, a farm walk was conducted with members of the Project Management Committee and the Unique Australian Dried Grapes Varieties Steering Committee to view the vineyard performance of the selections planted at the CSIRO Irymple farm and at the semi-commercial grower site. The farm walks were undertaken on the 19th of February in 2013, the 29th of January in 2014 and the 22nd of January in 2015. Both the Project Management Committee and the Unique Australian Dried Grape Varieties Steering Committee have been engaged in the assessment of dried grape samples of the most promising selections each season.

At the Project Management Committee meeting held on the 11th May, 2014 two promising selections were identified for inclusion in a PBR, DUS comparator trial. A further 2 promising selections which displayed excellent fruit quality attributes were also identified for inclusion in the PBR trial by the committee at its meeting on 4th May, 2015. At that meeting, the Project Management Committee indicated (1) that all promising selections with Sultana like characteristics should be grafted onto Ramsey and 1103 Paulsen for establishment in multiplied evaluation plots; (2) that the most promising selections identified for inclusion in the PBR trial should be established in a semi-commercial planting for evaluation on a grower site; and (3) suggested that no further work be undertaken with black seedless selections or the small berried white selections with the best being retained by CSIRO for future research purposes or to meet changing market requirements. The committee also agreed that it was too early to name and release a new variety to industry. These recommendations were also endorsed by the Unique Australian Dried Grape Varieties Steering Committee at its meeting on 10th August, 2015. The committee also supported development of a new, 3 year HIA project to complete the evaluation of the most promising CSIRO selections, complete the PBR process for the best selections identified as part of the new project for release to industry and put in place strategies for release to industry with establishment of mothervine plantings and propagation through licensed nurseries and field grafters.

In each year of the project, dried fruit samples of promising new drying selections were displayed at the Mildura Field Days held in Mildura in the last week of May.

An article was published in The Vine, Vol 8, Issue 2 (April-June 2012) indicating the role undertaken by Dried Fruits Australia in the project.

Outcomes

The project was designed to provide a direct benefit to the Australian dried vine fruits industry. It aimed to build on the previous CSIRO breeding projects and continue the evaluation of breeding lines to develop improved drying varieties with potential to enable the industry to meet future challenges associated with production in a variable and changing climate and overcome problems/deficiencies of existing standard varieties, as identified in the introduction above. While material across all categories of dried grape products was assessed (i.e. sultanas, currants and raisins), a focus of the study was the identification of alternative Sultana types, to overcome significant issues with the dominant variety, Sultana. These issues include production and quality losses associated with rain damage at harvest, the development of mouldy fruit and inconsistent production due to variable fruitfulness and biennial bearing.

Material evaluated included 1700 single vine seedlings, 360 promising selections which had been propagated in multiplied plots or top-worked/grafted onto existing material and 7 promising selections established on a grower site, for assessment under semi commercial conditions and to provide sufficient fruit for processing and test marketing. Over the course of the project, significant culling was undertaken with numbers reduced to approximately 200 seedlings and 150 multiplied selections. In summary the project has delivered 9 high priority Sultana types with a further 27 selected that require further evaluation. Of the high priority selections, 4 early ripening, rain tolerant types with excellent fruit quality attributes and high yield potential have been identified for evaluation under semi-commercial conditions on grower properties and included in a PBR comparator trial. It is likely that one or more of these Sultana types, once released after further data are collected in a new project, will offer potential as alternative Sultana types to assist the industry to address significant problems associated with the Sultana variety. Furthermore, these selections will provide growers with an extended range of varieties with different maturity dates to spread the risk associated with unfavourable drying conditions during the season. In addition, 3 high priority and 10 large berried Sultana types have been selected which offer the potential to extend the product range of light types available.

In addition to the Sultana types, 4 high priority and 12 other small berried types which produce fruit with light colour, were identified. Similarly, a further 13 black selections covering a range in berry size ranging from small currant types up to types with berries 50% larger than Sultana have been selected. Selections of both types will be retained by CSIRO for future research and be available for industry adoption if there is increased market demand for such products.

Evaluation and Discussion

The project continued the evaluation of dried grape germplasm material, generated in previous CSIRO breeding projects. It aimed to identify selections with potential to enable the industry to meet future challenges associated with production in a variable and changing climate and overcome problems/deficiencies of existing standard varieties. The project focused on identifying alternative types for the production of light coloured sultanas which would enable the industry to address problems associated with the Sultana variety. These issues include production and quality losses associated with rain damage at harvest, the development of mouldy fruit with Ochratoxin A development and inconsistent production due to variable fruitfulness and biennial bearing. Other small and large berried selections for the production of light dried products and a range of black selections were also dried and evaluated in each season. Weather conditions experienced before and during the drying period over the 3 seasons provided excellent opportunities to assess rain tolerance of selections.

The project evaluated dried grape germplasm material established by CSIRO in previous projects at various stages of development ranging from single vine seedlings, multiplied selections established in larger plots including a number which had been grafted onto rootstocks and selections established on a semi-commercial grower site. Although some selections cropped for the first time during the project, significant culling was undertaken with numbers reduced to approximately 200 seedlings and 150 multiplied selections. The culling process involved visual inspections prior to harvest to identify selections with low fruitfulness and yield potential, development of significant seed traces or seeds and berry size uniformity and flower sex, avoiding female types. Further selections were identified for culling after evaluation of the harvest data and dried grape samples. Key criteria used in the culling process were low yield potential, maturity date (discarding late ripening types), rain intolerance (discarding types with damaged berries showing obvious splitting), poor berry size uniformity, poor colour (discarding selections with dark dried fruit unsuitable for sultana like products), poorcolour uniformity, susceptibility to berry damage during harvesting and processing, presence of a significant lignified seed trace, lack of berry 'plumpness', poor visual characteristics of the skin surface and poor sensory attributes (texture and flavour). Further evaluation of the retained material is required to complete the evaluation of the CSIRO dried grape breeding lines and identify selections for release to industry.

The project has successfully identified a total of 36 selections for the production of light coloured sultana like products covering a spectrum of harvest dates which have met the key criteria with respect to rain tolerance, dried grape quality attributes and yield potential. Four of these have been identified for evaluation under semi-commercial conditions on grower properties and inclusion in a PBR comparator trial. Although no new varieties have been released as part of this project, it is likely that one or more of the Sultana types will be released once further data are collected in ensuing seasons, as part of a new project. Such varieties will enable growers to not only achieve high fruit quality and productivity, but minimize risks associated with rain damage and poor drying conditions associated with unfavourable climatic events. A further 13 larger berried selections have also been selected with potential to extend the product range of light types available.

In addition, 16 small berried types suited to light coloured dried grape production and 13 black selections covering a range in berry size ranging from small currant types up to quite large berries have been selected. These will also be retained by CSIRO for future research purposes and be available for industry adoption if there is increased demand for such products in the market.

Recommendations

1. It is recommended that a new 3 year project be developed to:-
    a. Complete the evaluation of the CSIRO dried grape germplasm material located at the CSIRO Irymple Farm including 200 seedlings and 150 multiplied selections.
    b. Establish the most promising 'Sultana type' selections identified in this project, as grafted vines on Ramsey and 1103 Paulsen rootstocks in multiplied blocks, to assess their management characteristics and yield potential under modern management practices.
    c. Establish semi-commercial sites for the 4 most promising Sultana types.
    d. Complete the establishment of the PBR comparator trial for the 4 most promising Sultana types to establish Distinctness, Uniformity and Stability. Once fully established, collect key data for PBR application when a decision is made to name and release to industry.
    e. Identify further selections for inclusion in PBR trials and semi-commercial sites.
    f. Establish mothervine plantings of the most promising selections to facilitate rapid industry adoption of new varieties, once a decision to release is made and ensure that adoption is not limited by the supply of material.
    g. Develop specific grower management information for any new varieties that are released.

    After 3 years of further evaluation it is expected that the project will deliver a range of material to industry at different stages of development. These would include:-

    - New varieties named and released with PBR protection for production of sultana like products.
    - A small number of highly promising selections, established in new PBR comparator trials and established in semi-commercial sites, with potential for naming and release. The plan would be to have no more than 10 selections in this category.
    - A limited number of promising selections, grafted on Ramsey and 1103 Paulsen rootstock established in multiplied blocks for assessment under modern management practices. The plan would be to have no more than 20 selections in this category.
    - A range of seedless germplasm material of product types, other than sultana types retained for future research, PBR purposes (e.g. parental lines) or for development of niche or alternative markets.

2. Retain the best small berried selections on the CSIRO property as part of the germplasm collection for future research purposes or release to industry if a market requirement for such products emerges. However, based on industry feedback, minimize future research effort for such types although noting that it is possible that new small berried types may be identified in remnant seedling populations.

3. Retain the best black selections on the CSIRO property as part of the germplasm collection for future research purposes or release to industry if a market requirement for such products emerges. However, based on industry feedback, minimize future research effort for such types, although noting that it is possible that new black berried types may be identified in remnant seedling populations.

Scientific Refereed Publications

None to report

Intellectual Property/Commercialisation

The key IP issue relates to the genetic material which has been evaluated in this project. CSIRO and HIA retain ownership of all genetic material which has been licensed to the project including seedlings, multiplied selections and selections identified or established in semi-commercial plantings. Dried Fruits Australia is the licensed commercialiser for varieties released from the program. For the purposes of this project, CSIRO made available to the project team all genetic material comprising the dried grape breeding program including seedlings, parents and advanced selections. Selections, for establishment on semi-commercial grower test sites, are only made available with appropriate CSIRO Plant Evaluation agreements in place. New varieties will be protected by Plant Breeders Rights (Australia), and equivalent overseas mechanisms in the event of the project steering committee deciding to license a variety in another country.

While no new varieties have been identified for naming and release to industry in this project, 4 selections have been identified for inclusion in PBR, DUS comparator trials established as part of the project on CSIRO property. This is to avoid delays once a selection is identified for future release. The comparator data will be collected as part of a new project submitted to HIA.

The royalty share will take into account investments by CSIRO and HIA (HAL) in past dried grape breeding and evaluation projects (CSH17, 24, 54, 60, DG01001, DG04003 and DG09000) and include investments by HIA in this project.

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