Department of Primary Industries

Southern NSW soybean breeding experiments – Leeton 2020

Tony Napier and John Dando
NSW DPI, Yanco

Key findings

- Burrinjuck$^{\Phi}$ achieved both a higher grain yield and protein content than Snowy$^{\Phi}$ when sown in mid November compared with a mid December sowing.
- One advanced new cross was identified with superior qualities to Burrinjuck$^{\Phi}$ and warrants further evaluation as a late sown clear hilum option.
- Sixty-five new Burrinjuck$^{\Phi}$ backcrosses were identified as suitable for further evaluation towards releasing an enhanced Burrinjuck$^{\Phi}$ line.

Introduction

The Yanco Agricultural Institute soybean project evaluates new lines from the Australian National Soybean Breeding Program aiming to release new varieties for southern NSW. The program is looking for new varieties that possess desirable combinations of yield, protein, improved agronomic traits, broad adaptation, disease resistance and high weathering tolerance.

The focus of the Riverina industry has been to breed suitable varieties for the human consumption market. Djakal is the current standard in the Riverina for the crushing market. It is high yielding but has a dark hilum making it undesirable for human consumption. The current standard for the soymilk market is Snowy$^{\Phi}$ with a clear hilum, but it is much lower yielding than Djakal.

Burrinjuck$^{\Phi}$, a clear hilum variety, was recently released for the human consumption market. Soymilk processors are yet to approve Burrinjuck$^{\Phi}$ as a preferred variety for their use, but approval is anticipated within 12 months. Burrinjuck$^{\Phi}$ has a significantly higher grain yield and protein content than Snowy$^{\Phi}$ when sown in mid November but has not always demonstrated an advantage when sown in late December. The breeding program is continuing to evaluate new crosses and aims to enhance Burrinjuck$^{\Phi}$ with powdery mildew and Phytophthora Root Rot resistance combined with resistance to sulfonylurea herbicides.

Site details

Location	Leeton Field Station
Soil type	Grey vertosol
Previous crop	2019 barley
Starter fertiliser	100 kg/ha Rustica Plus pulse mix (12:5:14)
Sowing dates	• S4 early experiment on 18 November 2019 • S4 late experiment on 17 December 2019 • S1 experiment (hill plots) on 20 January 2020
Harvest dates	• S4 early experiment on 15 April 2020 • S4 late experiment on 21 April 2020 • S1 experiment (hill plots) from 4 to 25 May 2020

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Treatments and establishment

Two S4 (F8 equivalent) experiments were established to evaluate new crosses, looking for new superior genotypes that are either suitable for human consumption or the crushing market.

One S1 (early generation) experiment was established to screen new enhanced Burrinjuck$^{\Phi}$ backcrosses with similar or improved grain yield and protein content as Burrinjuck$^{\Phi}$. S2 and S3 experiments are also conducted annually but are not reported in this paper.

S4 experiments (early and late)

The S4 experiments had 36 entries: 31 breeding lines and five commercial varieties (Burrinjuck$^{\Phi}$, Djakal, Snowy$^{\Phi}$, Bidgee$^{\Phi}$ and Bowyer). Both S4 experiments had four replicates in a randomised block design and were sown on raised beds at 1.83 m centres. There were two plant rows per bed with a plant row spacing of 0.915 m. Plots were two beds wide by 10 m long giving a total 36.6 m^2 plot area.

S1 experiment

Ninety new enhanced Burrinjuck$^{\Phi}$ backcrosses were evaluated in the S1 experiment, along with multiple plots of Burrinjuck$^{\Phi}$ as a control. The S1 experiment was sown on raised beds in single plots with no replication (due to limited seed).

Assessments

All plots were assessed twice weekly for physiological maturity before harvest. Plots were recorded as mature when 95% of pods had changed from a green colour to yellow (expressed as P95). Yield was calculated from 10 m of the centre two rows from each plot. Subsamples of grain were collected to calculate grain protein, moisture, oil content, seed size and hilum colour. Grain yield was calculated at 12% grain moisture and grain protein was calculated on a dry matter basis (DMB). Grain size was measured from a subsample of 200 grains.

Results

S4 early experiment

Grain yield averaged 3.81 t/ha across all cultivars. Burrinjuck$^{\Phi}$ achieved a grain yield of 4.14 t/ha, which was higher than Snowy$^{\Phi}$ (3.02 t/ha) (Table 1). No new cultivars achieved a significantly higher grain yield than Burrinjuck$^{\Phi}$.

Grain protein content averaged 40.15% across all cultivars. Burrinjuck$^{\Phi}$ achieved a protein content of 40.5%, which was significantly higher than Snowy$^{\Phi}$ (38.65%) (Table 1). Only the three new cultivars, 2B25-1230, 2B25-1238 and 2C17B-932-769 had a significantly higher grain protein content than Burrinjuck$^{\Phi}$ in the S4 early experiment.

Burrinjuck$^{\Phi}$ had a maturity time of 128.97 days which was similar to Snowy$^{\Phi}$ (128.66 days). Bidgee$^{\Phi}$ and eight new crosses were significantly quicker to mature than Burrinjuck$^{\Phi}$.

Burrinjuck$^{\Phi}$ achieved a grain size of 41.55 g/200 seeds and was similar to Snowy$^{\Phi}$ (40.52 g/200 seeds). Only the two new cultivars, 2C17B-933-803 and 2C17B-933-802 achieved a significantly larger grain size than Burrinjuck$^{\Phi}$.

S4 late experiment

Grain yield averaged 3.36 t/ha across all cultivars. Burrinjuck$^{\Phi}$ achieved a grain yield of 3.35 t/ha, which was statistically similar to Snowy$^{\Phi}$ (3.17 t/ha) (Table 2). Five new clear hilum cultivars achieved a significantly higher grain yield than Burrinjuck$^{\Phi}$.

Table 1 Hilum colour, grain yield, protein, time to maturity and seed size of each cultivar, presented in order of decreasing yield, in the Leeton Field Station early S4 variety evaluation experiment, 2019–20.

Cultivar	Hilum colour	Grain yield (t/ha)	Protein (%)	Maturity (days to P95)	Seed size (g/200 seeds)
2C15-573	Clear	4.19[a]	41.16	132.42	42.50[a]
2C17B-933-801	Clear	4.16[a]	40.76	130.02	41.59
2C15-566	Clear	4.14[a]	41.08	129.66	40.07
Burrinjuck	Clear	4.14[a]	40.50	128.97	41.55
2C17B-934-795	Clear	4.14[a]	40.41	132.21	39.93
P176-1-1	Clear	4.14[a]	39.62	123.01[a]	40.74
P176-2br	Dark brown	4.13[a]	39.01	131.94	35.58
P176-2-1	Dark brown	4.11[a]	39.38	121.91[a]	37.63
Djakal	Dark brown	4.09[a]	38.49	126.04	37.64
P176-37	Clear	4.08[a]	38.42	128.65	38.01
P176-2-2	Dark brown	4.07[a]	37.84	124.32[a]	36.25
2C17B-935-822	Clear	4.06[a]	40.63	135.18	40.72
2C17B-932-1A	Clear	4.02[a]	41.11	133.17	40.16
2C17B-933-803	Clear	4.00[a]	39.84	130.64	43.93[a]
2C17B-932-769	Clear	3.95[a]	41.62	128.71	40.32
P176-1-2	Clear	3.94[a]	39.49	123.10[a]	38.72
2C17B-932-2	Clear	3.88[a]	41.05	127.83	40.12
2C17B-933-802	Clear	3.88[a]	39.87	132.82	43.66[a]
P176-14-1	Clear	3.88[a]	38.59	128.65	38.57
2C17B-934-793	Clear	3.87[a]	39.96	132.97	39.80
2C15-550	Clear	3.86[a]	40.85	128.39	41.97
P176-14-2	Clear	3.85[a]	38.78	124.65	39.25
2C17B-931-1	Clear	3.83[a]	40.87	133.79	40.27
Q015A-6	Clear	3.80	40.51	124.38[a]	36.47
2C17B-928-800	Clear	3.79	40.50	130.57	40.90
2C15-593	Clear	3.73	40.76	130.16	38.74
P168-11	Clear	3.64	40.81	125.13	39.08
2C17B-928-797	Clear	3.56	39.84	127.99	40.36
P213-41	Clear	3.50	39.39	128.43	38.47
2B25-1238	Clear	3.49	42.04	124.70	40.88
2B25-1230	Clear	3.44	43.68[a]	129.26	39.77
P176-23	Clear	3.42	39.12	128.91	36.66
Bidgee	Clear	3.34	39.77	121.73[a]	32.83
Z009-627	Clear	3.26	41.24	130.07	37.79
Snowy	Clear	3.02	38.65	128.66	40.52
Bowyer	Light brown	2.88	39.88	132.34	39.59
Average		3.81	40.15	128.60	39.47
l.s.d.		0.36	1.02	2.53	1.63

[a] Numbers in the same column sharing the letter 'a' are in the top grouping and are not significantly different by l.s.d. test at $P = 0.05$.

Table 2 Hilum colour, grain yield, protein, time to maturity and seed size of each cultivar, presented in order of decreasing yield, in the Leeton Field Station late S4 variety evaluation experiment, 2019–20.

Cultivar	Hilum colour	Grain yield (t/ha)	Protein (%)	Maturity (days to P95)	Seed size (g/200 seeds)
P176-2-1	Dark brown	3.83[a]	39.15	108.73	38.00
P176-2br	Dark brown	3.83[a]	39.49	112.48	36.92
2C15-566	Clear	3.82[a]	42.18[a]	118.98	43.13
P176-14	Clear	3.76[a]	39.15	110.70	39.02
Z007K-2	Clear	3.74[a]	40.39	118.45	41.01
P176-14-2	Clear	3.73[a]	39.52	109.53	40.25
P176-1-2	Clear	3.66[a]	39.14	112.50	39.10
Djakal	Dark brown	3.63[a]	38.93	111.28	36.79
2C15-593	Clear	3.57	42.18[a]	120.47	40.95
P176-1-1	Clear	3.52	39.81	112.47	42.30
2C15-573	Clear	3.49	42.52	117.03	43.98
Q015A-6	Clear	3.47	40.71	108.52	37.89
M095-66-2	Clear	3.44	39.83	107.28	35.11
2C17B-928-800	Clear	3.39	41.53	119.03	45.03
M095-68-2	Clear	3.37	39.87	107.53	33.41
Burrinjuck	Clear	3.35	41.31	117.52	43.40
Bidgee	Clear	3.34	41.13	104.97[a]	33.27
2C17B-932-1A	Clear	3.33	41.91[a]	119.03	43.34
2C17B-931-1	Clear	3.31	41.91[a]	121.23	44.94
2C17B-932-769	Clear	3.31	42.20[a]	119.03	44.56
2C17B-933-801	Clear	3.29	41.99[a]	119.72	45.87[a]
2B25-1230	Clear	3.27	42.15[a]	112.98	41.42
2C17B-934-793	Clear	3.26	41.48	121.23	42.64
2C17B-933-803	Clear	3.24	41.99[a]	120.03	46.77[a]
2C17B-932-2	Clear	3.23	42.73[a]	117.98	43.38
2B22-851	Clear	3.22	41.54	117.97	39.18
2C15-550	Clear	3.20	42.10[a]	118.00	45.59
2C17B-935-822	Clear	3.20	42.40[a]	122.05	45.15
2C17B-933-802	Clear	3.17	41.37	120.50	46.59[a]
2C17B-934-795	Clear	3.17	41.23	119.25	42.26
Snowy	Clear	3.17	41.32	112.73	41.40
2B22-850	Clear	3.13	39.57	119.48	38.33
2B22-846	Light brown	3.08	39.56	118.47	41.20
2B22-847	Clear	3.03	40.64	115.52	43.01
2C17B-928-797	Clear	2.92	41.93[a]	117.02	44.68
Bowyer	Light brown	2.53	41.17	118.53	42.96
Average		3.36	41.00	115.78	41.47
l.s.d.		0.25	0.84	1.97	0.97

[a] Numbers in the same column sharing the letter 'a' are in the top grouping and are not significantly different by l.s.d. test at $P = 0.05$.

Grain protein content averaged 41% across all cultivars. Burrinjuck$^{\Phi}$ achieved a protein content of 41.31%. which was similar to Snowy$^{\Phi}$ (41.32%) (Table 2). Six new cultivars achieved a significantly higher grain protein content than Burrinjuck$^{\Phi}$.

Burrinjuck$^{\Phi}$ had a maturity time of 117.52 days, which was significantly longer than Snowy$^{\Phi}$ (112.73 days). Bidgee$^{\Phi}$ and eight new crosses achieved a significantly quicker maturity time than Burrinjuck$^{\Phi}$.

Burrinjuck$^{\Phi}$ achieved a grain size of 43.40 g/200 seeds and was significantly larger than Snowy (41.40 g/200 seeds). Nine new cultivars achieved a significantly larger grain size than Burrinjuck$^{\Phi}$.

S1 experiment

Burrinjuck$^{\Phi}$ plots in the S1 experiment ranged in maturity time from 112 to 114 days; the new lines ranged from 112 to 129 days. Four new lines had a maturity time longer than 120 days and were not considered suitable for further evaluation. In total, 90 new crosses were evaluated in the S1 experiment (results not shown).

The Burrinjuck$^{\Phi}$ plots achieved an average protein content of 43%; the new crosses ranged from 40.3% to 46.5%.

The Burrinjuck$^{\Phi}$ plots had an average seed size of 41 g/200 seeds; the new crosses ranged from 38.5 g/200 seeds to 45.9 g/200 seeds.

Discussion

Burrinjuck$^{\Phi}$ demonstrated superiority over Snowy$^{\Phi}$ in the S4 early experiment with higher grain yield and protein content. Burrinjuck$^{\Phi}$ did not demonstrate an advantage over Snowy$^{\Phi}$ in the S4 late experiment (similar grain yield and protein content). No new cultivars in the S4 early experiment had a higher grain yield than Burrinjuck$^{\Phi}$, while five new clear hilum cultivars in the S4 late experiment achieved a higher grain yield than Burrinjuck$^{\Phi}$.

In the S4 late experiment, three of the five new cultivars that had a higher yield than Burrinjuck$^{\Phi}$ also had a lower protein content. The other two higher yielding crosses in the S4 late experiment included Z007K-2, which had a similar protein content to Burrinjuck$^{\Phi}$ and 2C15-566, which had a higher protein content than Burrinjuck$^{\Phi}$.

Burrinjuck$^{\Phi}$ had a similar maturity time to Snowy in the S4 early experiment, but took nearly five more days to mature in the S4 late experiment. The two new crosses (Z007K-2 and 2C15-566) in the S4 late experiment, with superior yield and high protein content, both had a similar maturity time to Burrinjuck$^{\Phi}$.

In the S4 late experiment, Z007K-2 had a smaller grain size than Burrinjuck$^{\Phi}$, while 2C15-566 had a similar grain size to Burrinjuck$^{\Phi}$.

The only identified new breeding line with superior qualities to Burrinjuck$^{\Phi}$ in the S4 experiments was 2C15-566 at the later sowing date.

In the S1 experiment, 65 new Burrinjuck$^{\Phi}$ backcrosses were identified as suitable for further evaluation.

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Contact

Tony Napier
Yanco Agricultural Institute, Yanco
tony.napier@dpi.nsw.gov.au
0427 201 839