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Soybean variety evaluation – Tabulam, NSW 2018–19

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Key findings

- The two new lines T171A-2 (2.74 t/ha) and NK94B-25 (2.51 t/ha) had yields that were statistically similar to the industry standard variety RichmondA (2.28 t/ha).
- Richmond$^{\Phi}$ had a grain protein concentration of 45.2% on a dry matter (DM) basis, which was significantly higher than the varieties T171A-2 (43.0 %) and NK94B-25 (43.4%).
- There was significant difference in seed size between varieties. Richmond$^{\Phi}$ produced the largest seed size (25.7 g/100 seeds), followed by T171A-2 (23.4 g/100 seeds) and NK94B-25 (21.3 g/100 seeds).
- No significant difference in grain oil concentration, plant height, and lodging score was observed between the three lines.
- Downy mildew, a leaf disease, was identified in the experiment, but not at an economically significant level.
- Adaptation of the two unreleased lines to the North Coast region of New South Wales (NSW) was validated through this experiment.

Introduction

In recent decades, the Australian Soybean Breeding Program (ASBP) has transformed Australian soybean (*Glycine max*) varieties in response to industry calls for varieties with superior quality grain traits. These include high protein, large seed size and clear hilum to supply the high value human consumption markets in Australia and internationally. In 2017, the Grower Variety Selection Committee (GVSC) was formed, and in consultation with the ASBP re-focused on selecting high yielding lines for northern NSW. Data from past seasons were assessed and several high yielding lines with adequate grain quality levels were chosen for on-farm evaluation in the summer of 2018–19.

The GVSC was formed to allow growers greater involvement in selecting new varieties from the breeding program and to participate in data review and on-farm evaluation. It consists of six grower members from the north coast region of NSW, and three NSW DPI representatives. The growers include Kevin Twohill (Murwillumbah), Paul Fleming (Codrington), Kate Dowley (Tabulam), Ben Clift (Codrington), Shane Causley (Warregah Island) and Alan Munro (Woodford Island). The NSW DPI representatives are Dr Natalie Moore (Research Agronomist), Nathan Ensbey (Technical Officer) and Sam Blanch (Technical Assistant).

A replicated, on-farm experiment was conducted at Tabulam in northern NSW to assess two advanced, unreleased high yielding lines against the known Australian industry standard variety, Richmond$^{\Phi}$.

Site details

Location	Growvale Trust, Plains Station Road, Tabulam, NSW 2469 (Latitude 28°57′23.2″S, Longitude 152°32′52.0″E)
Paddock history	• Summer 2017–18: Soybean • Winter 2018: Wheat
Co-operator	Kendall and Kate Dowley, Growvale Trust

Soil type and nutrition	• Brownish loam pH_{Ca} 5.6 • Subsoil constraints were not evident at this site. • Table 1 shows the soil chemical analysis.
Rainfall and temperature	Total rainfall from November 2018 to April 2019 was 346.2 mm, which is 53% less than the long-term average of 742.3 mm for this location. There was no rainfall in January 2019, with the remaining months receiving substantially less than long-term rainfall averages (March excluded) (Figure 1). Higher than average temperatures were recorded during the growing season, which could have negatively affected plant growth.
Experiment design	• Randomised complete block design. • Three replicates and three varieties. • Each plot was 4.87 m (6 rows) wide and approximately 95 m long. • Row spacing was 0.8 m.
Planting date	29 December 2018
Fertiliser	400 mL/ha Como® (cobalt 1% and molybdenum 6%) applied over crop rows on 4 February 2019
Target plant population	20 plants/m^2
Weed management	• Starane® Advanced 450 mL/ha (333 g/L fluroxypyr), fallow weed control. • Weedmaster® Argo® 1.8 L/ha (540 g/L glyphosate) was applied on 23 November 2018. • Spinnaker® 140 g/ha (700 g/kg imazethapyr) and Dual Gold® 2.0 L/ha (960 g/L s-metolachlor) was banded over at planting. • Weedmaster® Argo® 1.8 L/ha (540 g/L glyphosate), mixed with enhance oil at 500 mL/100 L and applied on 6 February 2019. • Reglone® 2.2.0 L/ha (200 g/L diquat) applied on 5 May 2019 before harvest.
Insect management	• Targeting larvae of *Helicoverpa armigera*: ViVus® Gold 375 mL/ha (polyhedral inclusion bodies of the *Nucleopolyhedro* virus of *Helicoverpa armigera*) applied 5 February 2019. • Targeting brown eggs and hatchling to small larvae of *Helicoverpa* spp: DuPont™ Steward® EC 400 mL/ha (150 g/L indoxacarb) applied on 18 February 2019. • Controlling Lepidopteran species: DuPont™ Altacor® (350 g/kg chlorantraniliprole) at 70 g/ha applied on 7 March 2019.
Disease management	No diseases of economic significance developed in the experiment. Some downy mildew (*Peronospora manshurica*) was present, but not at an economically significant level.
Harvest date	10 May 2019.

Table 1 Soil analysis of Growvale Trust, Tabulam, NSW, 2018–19.

Measurement	Value
Soil pH (1:5 water)	5.6
Estimated organic matter (% OM)	2.9
Sulfur (mg/kg)	5.6
Nitrate nitrogen (mg/kg)	17.4
Ammonium nitrogen (mg/kg)	2.2
Phosphorus (mg/kg) [Bray 1 test]	33
Phosphorus (mg/kg) [Bray 2 test]	63
Phosphorus (mg/kg) [Colwell test]	71
Potassium (%)	5.4
Calcium (%)	75.3
Magnesium (%)	17.2
Sodium – ESP (%)	0.7
Aluminium (%)	0.5
Electrical conductivity (dS/m)	0.062
Effective cation exchange capacity (ECEC) (cmol+/kg)	8.2
Zinc (mg/kg)	4.8
Copper (mg/kg)	0.6
Iron (mg/kg)	195
Manganese (mg/kg)	14
Silicon (mg/kg)	33

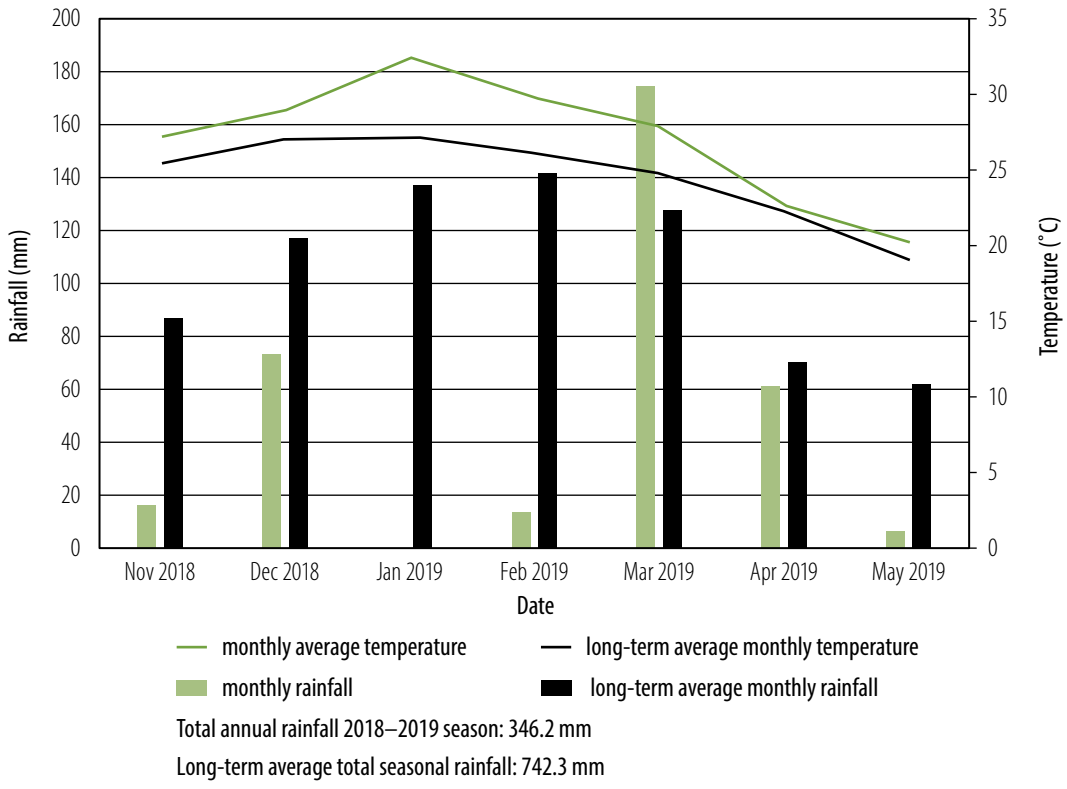

Figure 1 Comparison of growing season rainfall and temperature at Tabulam, NSW 2018–19 with long term average rainfall and temperature data. Raw data was obtained at http://www.bom.gov.au/climate/data/ (BOM 2019.)

Treatments

Varieties (3)

Commercial standard Richmond[Φ] and unreleased lines NK94B-2 and T171A-2.

Table 2 contains a short description of variety traits and why they were included.

Table 2 Description of soybean varieties in the experiment at Tabulam, NSW 2018–19.

Treatment number	Variety	Variety traits and reason for inclusion in the experiment
1	Richmond	Industry standard with high weathering tolerance, high protein, clear hilum and high yield, suited to an early–mid planting date in the North Coast and northern slopes regions of NSW.
2	NK94B-25	Unreleased line with high yield potential, clear hilum, suited to an early–mid planting date.
3	T171A-2	Unreleased line with high yield potential, clear hilum, suited to an early planting date, resistant to soybean leaf rust, narrow leaf shape.

Results

Establishment

The planting date was three weeks later than planned due to prolonged dry weather. However, all varieties established well and evenly in the experiment (Figure 2).

Figure 2 An on-farm evaluation of unreleased soybean lines was conducted at Growvale Trust, Kendall and Kate Dowley's property at Tabulam. The farming system uses wide (0.8 m) row spacing and double cropping soybean with winter cereal. Photo N. Ensbey NSW DPI.

The established plant population ranged from 243,000 plants/ha to 270,000 plants/ha, within the target range. The unreleased line NK94B-25 developed the bushiest growth habit and line T171A-2 appeared to adapt well to the hot, dry weather with a dense canopy and good pod set (Figure 3). As the grower inadvertently planted over Replicate 2 of line T171A-2, data was only taken from two replicates of this treatment, not from three replicates as for the other treatments.

Figure 3 Soybean line T171A-2 in the on-farm evaluation at Tabulam. Photo N. Moore NSW DPI.

Lodging, leaf diseases and maturity

All soybean varieties in the experiment showed high stand-ability with no lodging observed. Downy mildew leaf disease was detected, but there was no significant damage to soybean plants that would results in yield loss. All varieties matured at an acceptable time for harvest.

Plant height at maturity

Plant height was measured at crop maturity. Line NK94B-25 was the tallest variety at 54.8 cm, followed by line T171A-2 at 51.37 cm and the commercial variety Richmond(Φ) the shortest at 45.43 cm (Table 3). There was no significant difference in the data for plant height.

Grain yield

The data was analysed by Stephen Morris (Biometrician, NSW DPI Wollongbar) using spatial analysis with an ASReml package (Butler et al., 2017) in the R environment (R Development Core Team 2017). Differences between results that exceed the estimate of least significant difference (l.s.d.) can be regarded as statistically significant at the 5% critical value ($P<0.05$).

Line T171A-2 yielded 9% higher than line NK94B-25 and 17% higher than variety Richmond(Φ) (Table 3), however, when analysed there was no statistically significant difference between the yields of the three varieties in this experiment. Figure 4 gives a visual representation of the variation in yield between the field replicates in the experiment.

Table 3 Analysed data of soybean variety evaluation at Tabulam, NSW 2018–19.

Soybean variety	Grain yield (t/ha)	Seed size (g/100 seed)	Grain oil content (% DM)	Grain protein content (% DM)	Plant height (cm)
T171A-2	2.74 [a]	23.4 [c]	20.3 [a]	43.0 [b]	51.4 [a]
NK94B-25	2.51 [a]	21.3 [b]	20.8 [a]	43.4 [b]	54.8 [a]
Richmond(Φ)	2.28 [a]	25.7 [a]	19.8 [a]	45.2 [a]	45.4 [a]
l.s.d. (P<0.05)	1.16	1.79	1.08	1.15	10.23

l.s.d. = least significant difference at the 5% critical value ($P<0.05$)
Note: values with the same letter are not significantly different

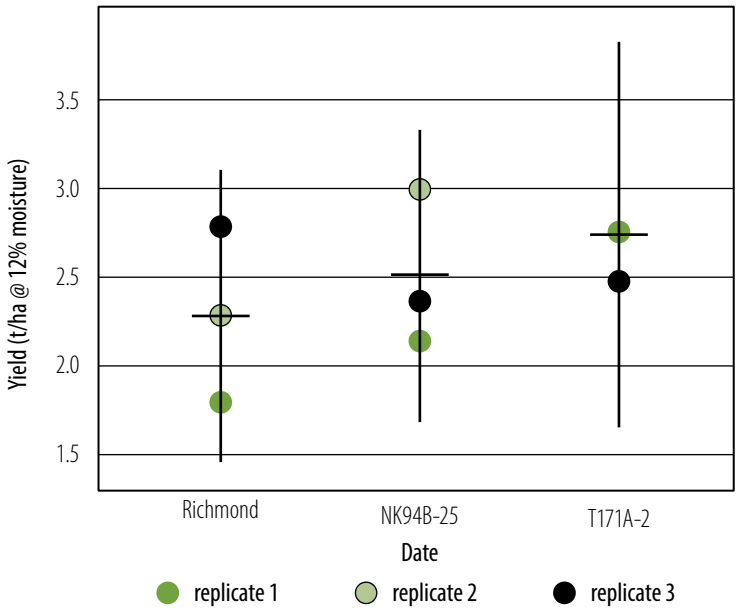

Figure 4 Average yields of the three varieties plotted with the mean of three replicates (replicate 2 of T171A-2 is not included) at Tabulam, NSW 2018–19.

Seed size

Seed size was measured as the weight of 100 seeds at 12% moisture content. The difference in seed size between three lines was significant, ranging from the largest for standard variety RichmondA (25.7 g/100 seeds) to the smallest, NK94B-25, at 21.3 g/100 seeds. T171A-2 was the mid-size seed size recorded at 23.4 g/100 seeds (Table 3).

Grain protein and oil content

All varieties produced protein content above the industry standard of 40% DM. The protein content of variety Richmond$^{\Phi}$ (45.0% DM) was significantly higher than the two unreleased lines NK94B-25 (43.4% DM) and T171A-2 (43.0% DM) (Table 3). There was no statistically significant difference between the protein content of NK94B-25 and T171A-2.

For grain oil content, the three treatments NK94B-25 (20.8% DM), T171A-2 (20.3% DM), and Richmond$^{\Phi}$ (19.8% DM) were statistically similar (Table 3).

Conclusions

Average rainfall during the growing season was 53% of the long-term average for the region. This, combined with the higher temperature during the growing season, could have negatively affected plant growth and decreased the experiment's overall yield. The collaborating grower confirmed that soybean yield was lower than average for their farm this season. However, the two unreleased lines and Richmond$^{\Phi}$ adapted well to the unfavourable conditions and established evenly. Results indicate that the two unreleased soybean lines (NK94B-25 and T171A-2) performed similarly to the high yielding commercial variety Richmond$^{\Phi}$ and produced acceptable protein content and seed size, confirming their adaptation to the North Coast region of NSW. The growers commented favourably on the establishment and yield of line T171A-2, and expressed interest in evaluating the variety again. Although no soybean leaf rust developed in this experiment, the resistance of line T171A-2 to this disease is considered as a valuable trait to protect high yield potential in high rainfall seasons.

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