Soybean trials in northern Victoria & the Riverina

Felicity Pritchard[1], Luke Gaynor[2] & Dale Grey[3]
[1]Oilseeds Industry Development Officer, Irrigated Cropping Forum, [2]Technical Officer NSW DPI Wagga Wagga, [3]Senior Agronomist Vic. DPI Cobram

in a nutshell

- Trial results in 2005–06 and averages over the last five years show Djakal to be the top-performing soybean variety in northern Victoria and the Riverina
- The variety Snowy released in 2005 also performed well, and together with Djakal these varieties are proving to be higher yielding and have better end-use quality than older varieties, and their quicker maturity means they use less water
- Another trial in 2005–06 showed that row spacing and choice of variety can have a major effect on irrigated soybean yields, with the research indicating that significant yield gains can be achieved through the use of narrow rows

The area planted to soybeans in southern NSW more than doubled from 1570 ha in 2004–05 to 3650 ha in 2005–06, averaging an estimated 3.3 t/ha, with top yields of 4.6 t/ha.

The main varieties grown in 2005–06 were Djakal and Snowy, which are higher yielding and of better end-use quality than older varieties due to their larger seed size, higher protein and tofu-making qualities. These varieties are also faster-maturing, making them more suitable to double-cropping programs. In addition, many growers have found that due to the earlier maturity of Djakal and Snowy, these varieties generally require one less watering and are therefore more water use efficient. Snowy is considered premium quality for export markets, in particular the tofu market.

The following information summarises some of the results from the research into soybean breeding and agronomy in northern Victoria and the Riverina.

Soybean evaluation trials

A range of varieties and advanced breeding lines of soybeans was evaluated in four trials across northern Victoria and the Riverina in the 2005–06 season. The trials were conducted to evaluate newly-crossed breeding lines from first generation field trials up to the advanced replicated regional trials and newly-released varieties from the National Soybean Improvement Program. All varieties/lines included in the trials were culinary types, except Stephens, which is a black-hilum crushing variety.

Trial details

In northern Victoria, breeding lines were replicated three times in randomised complete blocks at sites at Katandra and Corop. In southern NSW at Leeton and Coleambally, lines were replicated four times in randomised complete block designs. Advanced lines were also tested across a range of sowing dates, from early, ideal and late planting dates.

Details of the trial site and the management at each site are given in Table 1.

2005–06 yields

The yield results for the trials are given in Table 2 and maturity (days from sowing to physiological maturity) for each of the tested varieties/lines is given in Table 3.

Figure 1: Luke Gaynor, NSW DPI, and Jim Maskus, Whitton, harvesting Djakal soybeans near Leeton in April 2006

Table 1: 2005–06 trial site details						
Coordinator	**Luke Gaynor, NSW DPI**				**Dale Grey, Vic DPI**	
Site	**Coleambally**	**Leeton**			**Katandra**	**Corop**
Cooperator	**Bellato**	**NSW DPI**			**Tige Gardner**	**Geoff Spencer**
Sowing date	14 November	25 November	23 December		15 November	1 December
Soil type	Grey self-mulching clay	Grey self-mulching clay			Red loam	Grey self-mulching clay
In-crop rainfall (mm)	NA	42 mm			118 mm	96 mm
Irrigation (ML)	8	8	7		6.5	
Method	Raised beds (1.83 m)	Raised beds (1.83 m)			Border check	Drip irrigated beds
No. irrigations		10	9		10	
Harvest	27 March	12 April			12 April	20 April
Fertiliser		250 kg legume starter			40 kg P/ha as single super	25 kg P/ha as single super
Previous winter crop	Fallow	Fallow			Oaten-vetch Hay	Fallow
Previous summer crop	Soybeans	Fallow			Maize	Tomatoes

Table 2: Off-header yields (t/ha) for Victoria, and seed-graded yields (t/ha) for southern NSW of soybean varieties and selected advanced breeding lines for 2005–06 harvest

Variety/line	Katandra	Coleambally	Leeton Nov sown	Leeton Dec sown	Variety mean	Corop*
Djakal	5.04	3.35	3.99	3.95	***4.08***	3.21
Snowy	4.46	2.72	3.44	3.68	***3.58***	2.60
99091A-4	4.55	2.95	3.50	3.39	***3.60***	3.29
F190-6	4.30	2.84	3.55	3.69	***3.60***	*
F148-3	4.58	2.95	3.42	3.64	***3.65***	*
Stephens	4.97	2.90	3.32	3.65	***3.71***	*
F147-5	4.52	2.90	3.43	3.74	***3.65***	*
Empyle	4.04	2.91	3.57	3.81	***3.58***	3.13
F148-4	4.65	2.75	3.34	3.80	***3.64***	3.46
Curringa	3.85	2.52	3.17	3.52	***3.27***	3.29
96248-23	4.13	2.47	3.06	3.21	***3.22***	3.16
Bowyer	3.17	2.35	2.97	3.67	***3.04***	*
Site mean	***4.36***	***2.80***	***3.40***	***3.65***	***3.55***	

*Corop data analysed separately, using ANOVA. All other data analysed with AS-REML.

Table 3: Number of days from sowing to physiological maturity (P95) at Leeton (two sowing dates), Coleambally and Katandra in 2005–06

Variety/line	Leeton Nov sown	Leeton Dec sown	Coleambally	Katandra
Bowyer	127	121	128	*
Curringa	126	118	127	134
Snowy	123	103	120	134
Empyle	121	103	118	132
96248-23	118	99	114	128
Djakal	117	99	112	129
Site mean	***122***	***107***	***120***	***132***

Long-term yields for both regions

Long-term data (Table 4) were based on trail results from the northern Victorian sites for five trials from 2001–02 until 2005–06 at Congupna and Katamatite. In the Riverina, long-term data were derived from 12 trials from Leeton (two sowing dates) and Coleambally from 2003–04 until 2005–06.

The long-term data show that Djakal is the highest yielding variety, followed by Empyle and Snowy. The newer varieties such as Snowy and Djakal, which tend to be faster maturing, have consistently and significantly out-yielded older varieties such as Stephens, Curringa and Bowyer, especially in the Riverina.

What does the long-term data mean?

Djakal remains the top-performing variety, with very robust yields across all conditions and a range of sowing dates over a number of years (Table 2). It is very well suited to double-cropping because of its fast maturity, high yields and very quick dry-down finish.

Djakal and the recent new release Snowy have lifted the yield potential of the culinary-type soybeans. Generally Djakal and Snowy's yields are very similar and not significantly different. Further, the varieties are more water use efficient as they produce higher yields and may require one less watering than the older, later maturing varieties. However, Snowy is slightly later maturing than Djakal (Table 3).

Snowy and Djakal have the potential to fit into both the premium culinary and the crushing markets. Snowy is the first clear hilum variety, and is highly desirable for export markets.

The two new varieties have different genetic backgrounds for resistance to the disease Phytophthora root rot. Where two soybean crops are grown in succession and there is a history of phytophthora present in the farm/area, Snowy and Djakal can be rotated as a disease management strategy.

Soybean row spacing by plant density trial

In the Riverina, soybeans are commonly sown in wide rows, with two rows per 1.8 m raised bed. However, in northern Victoria, soybeans are usually sown in more narrow rows (17–20 cm) on border check layout. Both methods allow growers in each district to use conventional winter cropping equipment for sowing.

Past research has found that row spacing can have a major impact on yields of irrigated soybeans, while the effect of plant density has been inconsistent. Narrower row spacing can be used as a part of an integrated weed management strategy.

Table 4: Long-term mean yields of soybean varieties and advanced breeding lines for Victoria (2001–02 to 2005–06) (off-header yields) and Riverina (2003–04 to 2005–06) (seed graded yields)

Variety	Year of release	Northern Victoria	Riverina	Variety mean
Djakal	2001	3.91	3.97	***3.95***
Snowy	2005	3.39	3.52	***3.48***
Empyle	2001	3.56	3.54	***3.55***
96248-23	To be released	3.01	3.08	***3.06***
Stephens	1987	3.15	3.44	***3.35***
Curringa	1999	2.84	3.28	***3.15***
Bowyer	1982	2.81	3.00	***2.94***
Site mean		***3.24***	***3.40***	***3.36***
No. trials		5	12	

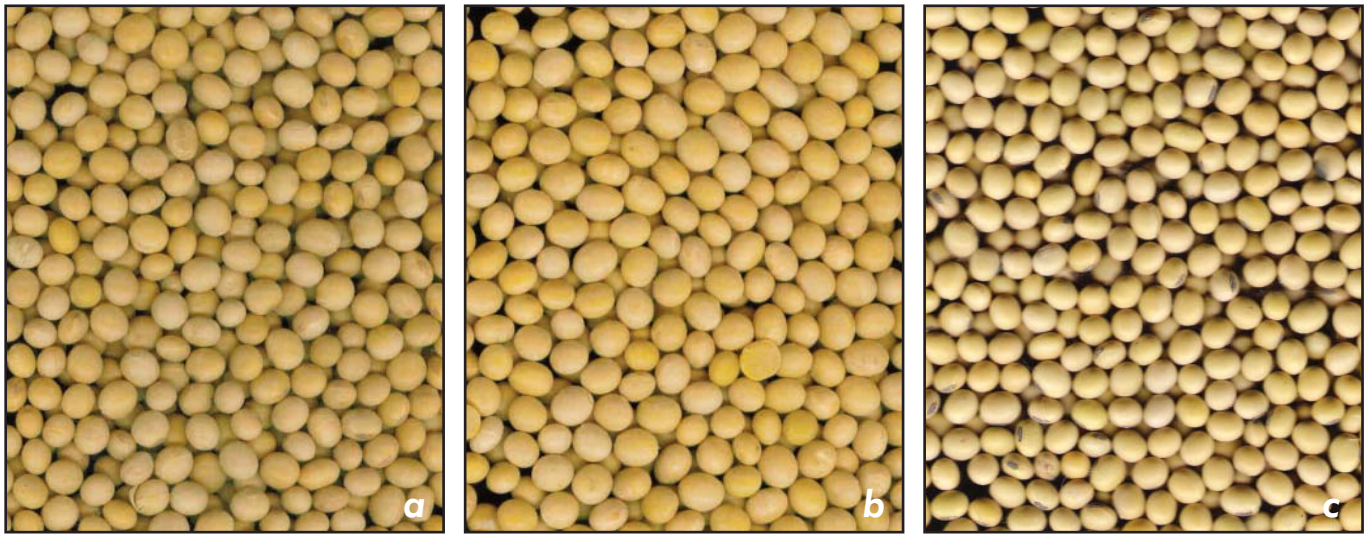

Figure 2: a) Djakal (buff hilum), b) Snowy soybeans (clear hilum) and c) an older variety, Banjelong (dark hilum)

The trial was conducted to see which row spacings and plant densities produce the highest yields and optimum grain size on irrigated border check soybeans in northern Victoria.

Trial description

The varieties Djakal and Snowy and the advanced breeding line 96248-23 were sown at rates to give targeted plant densities of 40 plants/m^2 and 60 plants/m^2, at 35 cm and 70 cm row spacing at the Katandra site (see Table 1 for site details). The actual average plant densities achieved were 33 and 49 plants/m^2 for Djakal, 31 and 45 for Snowy, and 39 and 59 plants/m^2 for 96246-23, and are cited as approximately 35 and 50 plants/m^2. Variations in water use were not measured.

Results

Wider row spacing reduced yields by 12% in the trial. Highest yields were achieved with narrower row spacings for all varieties. In addition, the narrower row spacings were observed to have fewer weeds and faster canopy closure.

On average across all treatments, Djakal yielded 10% more than Snowy and 20% more than 96246-23. Plant density did not affect yields (Table 5).

What do the results mean?

This trial shows that row spacing and the choice of variety can have a major effect on irrigated soybean yields.

This research has indicated that significant yield gains can be achieved through the use of narrow rows. Wider rows are used in southern NSW to allow for row cropping techniques and the use of existing machinery. This includes precision planters (which help guarantee correct plant densities), and the use of inter-row cultivators and sprayers for weed control, which are used for other crops such as cotton and maize. Soybean growers in the Riverina should seriously consider the benefits and disadvantages of changing their sowing methods.

Row spacing has a considerable effect on yields because it is related to the crop's ability to capture sunlight and accumulate leaf area (biomass), which in turn, leads to grain production (when other factors like water are not limiting).

Previous research in Australia and the United Stated of America has shown that in the early growth stages, of a soybean crop, light interception is related to the proportion of ground covered by the crop's leaf canopy. Closer row spacing improves the crop's light interception. The results of this trial are consistent with past research in Queensland which showed that closer spacing of soybeans led to faster development of leaf area/biomass, but higher water use. In an irrigated situation, this has lead to higher yields.

Although row spacing affected yields in this trial, plant density did not. Similarly, other research has also shown that although higher plant densities of grain legumes increased crop growth rates and water use, this did not result in better yields. This was probably due to competition between plants within a row for, nutrients and light, and, possibly water. However, it appears more local research is needed on the topic, as other work in the USA has found that soybean yields could be lifted by increasing plant populations when sowing in narrow rows in both irrigated and rain-fed crops (except where lodging occurs).

Further research is currently being undertaken to study the effect of the spatial arrangement of soybeans on biomass and yields, using a range of sowing dates. This may help overcome yield penalties associated with late sowing. However, at this stage, it is advised to sow soybeans on time in the ideal window for the region to achieve maximum yields. This work is currently in progress in southern NSW at NSW DPI Leeton Field Station, in collaboration with CSIRO and James Cook University. Results are unavailable at time of writing.

One of the trial's aims was to determine the effects of plant density and row spacing on grain size, but at the time of writing, quality data from the trial are unavailable. In a similar trial undertaken by the Victorian DPI in 2003–04, grain size was unaffected by row spacing. Similarly, Queensland research has found that wider plant spacing reduces the number of pods per plant of irrigated soybeans, more than increasing the grain size.

Soybean outlook – markets and research

As export markets develop, and if the Japanese yen strengthens, growers are likely to benefit from the greater demand and prices for the light hilum varieties Djakal and Snowy. In addition, a return to normal levels of production this season will further improve the price of soybeans in the Riverina and northern Victoria.

The soybean breeding program will continue in 2006–07 in the Riverina through the NSW DPI, and variety demonstrations will also be undertaken in northern Victoria.

The trial to evaluate the effects of variety, plant density, row spacing, sowing date, and their interactions will also continue this season at Leeton Field Station.

Acknowledgements

We acknowledge the assistance of Chris Lisle, NSW DPI, Wagga Wagga, for biometrical analyses, Don McCaffery for reviewing the article and the GRDC for project funding.

Table 5: Effect of row spacings and approximate plant density on yields (t/ha) of three soybean varieties/lines

Row spacing	***35 cm***		***35 cm row mean***	***70 cm***		***70 cm row mean***	***Variety mean***
Plant density (plants/m^2)	35	50		35	50		
Djakal	5.09	5.25		3.98	3.96		***4.57***
Snowy	4.58	4.72		3.51	3.57		***4.10***
96246-23	4.09	4.29		2.97	3.33		***3.67***
Treatment mean	***4.59***	***4.75***	***4.67***	***3.49***	***3.62***	***3.55***	***4.11***

LSD (comparing widths) = 0.24; LSD (comparing varieties) = 0.29; LSD for plant density and all interactions were not significant. Data analysed by ANOVA.

Further information

Luke Gaynor
T: 02 6938 1657 or 0428 260 156
E: luke.gaynor@dpi.nsw.gov.au

Felicity Pritchard
T: 03 5382 4396 or 0427 600 228
E: oilseed@irec.org.au

Dale Grey
T: 03 5871 0600 or 0409 213 335
E: dale.grey@dpi.vic.gov.au

Further reading

RA Ball, LC Purcell and ED Vories. (2000) Optimizing soybean plant population for a short-season production in the southern USA. Crop Science, ***40***, *757-764.*

DA Charles-Edwards and RJ Lawn. (1984) Light interception be grain legume row crops. Plant, Cell and Environment, ***7***, *247-251.*

RJ Lawn (1983) Response of four grain legumes to water stress in south-eastern Queensland. IV. Interaction with sowing arrangement. Australian Journal of Agricultural Research, ***34***(6) *661-669.*

GJ Leach and DF Beech. (1988) Response of chickpea accessions to row spacing and plant density on a vertosol on the Darling Downs, south-eastern Queensland. 2. Radiation and interception of water. Australian Journal Experimental Agriculture, ***28*** *(3), 377-383.*

Figure 3: Whitton grower Wayne Williams in crop of Snowy soybeans, April 2006