

# Soybeans in the Buff: Variety evaluation and selection for southern New South Wales

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## Abstract

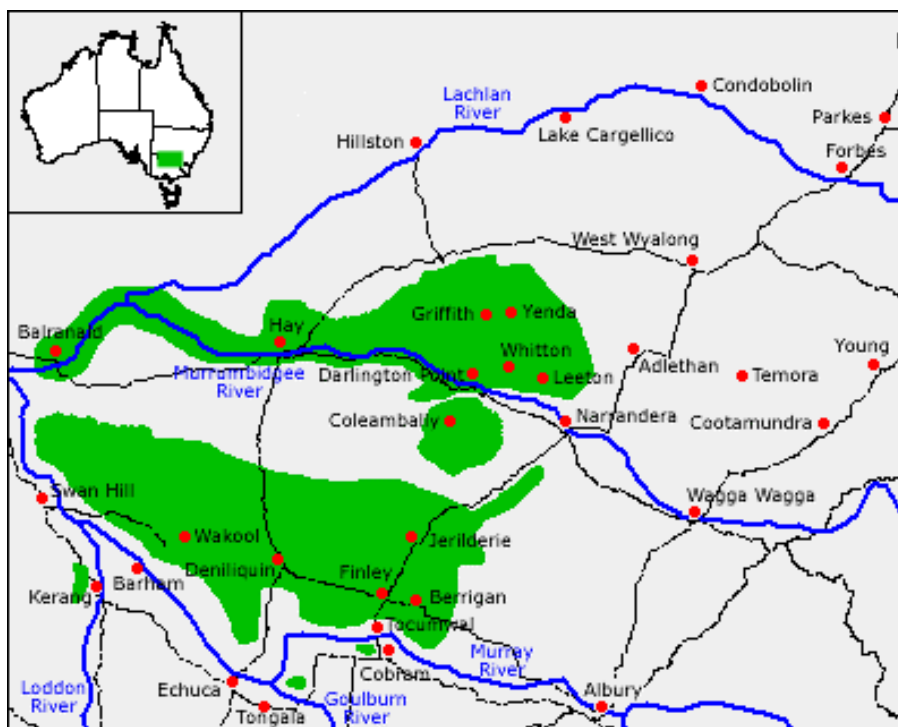
The main objective of the Southern NSW Soybean Improvement Program is to breed light hilum culinary soybeans that outclass existing varieties. Overall for a variety to be released, it must be of a light hila culinary type that matures earlier than current varieties, have phytophthora *sojae* root rot resistance, is high yielding, shattering and lodging resistant, have intact seed coat and some weathering tolerance. All soybeans grown in southern NSW are irrigated crops. Inland irrigation areas of southern New South Wales and northern Victoria have a uniquely drier climate that favours the production of high physical quality, light hila culinary soybeans for local and export edible markets. The breeding program has shifted its emphasis from black hilum crushing beans to clear hilum tofu quality beans that meet this criterion. Currently, some promising lines are in their final stages of evaluation. Recent releases, Djakal and Curringa allow growers to grow light hila culinary soybeans without sacrificing yield, prolonging the maturity of the crop and with improved resistance to phytophthora and weathering. This increases the profitability of the overall crop, with premium prices paid for these high quality edible beans.

**Keywords:** Soybeans; Breeding; southern NSW, Culinary.

## Introduction

The southern New South Wales Soybean Improvement Program is conducted in the Murrumbidgee Irrigation Area (MIA) and the Coleambally Irrigation Area (CIA). Trials are conducted by NSW Agriculture's Yanco Agricultural Institute (YAI) at Leeton Field Station (LFS) and in the Coleambally district (CIA) (see Figure 1). Latitude of growing regions is approximately 35°S.

Figure 1. Map and location of Southern NSW Irrigation Areas (shaded areas).



All soybeans grown in southern NSW are irrigated crops. Inland irrigation areas of southern New South Wales and Northern Victoria have uniquely drier climate that favours the production of high physical quality, light hila culinary soybeans for local and export edible markets (Colton, 2000). With this advantage in mind, the Soybean Improvement Program has in recent years, shifted its emphasis from black hilum crushing beans to clear hilum tofu quality beans. With recent soybean releases such as Djakal and Curringa, growers can now grow light hila culinary soybeans without sacrificing yield or prolonging the maturity of the crop. This increases the profitability of the overall crop, with premium prices paid for these high quality edible beans.

Traditionally black hila varieties have been grown for the crushing market, however there is no reason why Djakal or Curringa cannot also be grown for the crushing market. The current advantages over current black hila varieties are that it has:

- higher yield potential;
- significantly earlier maturity (Djakal);
- may require one less irrigation;
- higher protein which would be an advantage for the crushing market.

An expansion of the main breeding objectives is as follows:

**Maturity:** An earlier maturity is important to allow for an earlier harvest before Autumn rains begin, fits better into double cropping rotations with more time for the farmer to plant & harvest, and provides a shorter window for pest attack. Theoretically early maturing varieties can also reduce the amount of irrigation water used per hectare, without sacrificing any yield or quality. This allows the grower to plant a larger area of soybeans with the same amount of water as previously used for longer maturing varieties.

**Phytophthora sojae Root Rot:** Breeding for resistance offers the only long-term solution to the disease. Races 1, 4, 15, 25, 33, 46, & 53 have all been isolated from samples collected in Southern NSW, particularly the CIA region (Ryley and Drenth, 2000). Gene Pyramiding in the breeding program and molecular marker technology is currently being utilised to identify lines that have resistance to current phytophthora races.

**Yield:** An increase in soybean grain yield is a desired outcome to increase the profits at farm gate level. This will benefit both small and large scale growers to increase returns on a per hectare basis, as well as on a per mega-litre basis. With the current restriction of water allocations, farmers are monitoring water use efficiencies of crops and what returns can be made from these. New shorter season soybeans have proven very efficient and profitable when compared to other irrigated crops such as rice.

**Seed Quality that meets culinary market standards:** The breeding program is targeted at releasing varieties that greatly enhance the potential for high value export markets. Culinary soybeans that are large seeded, have high protein, high tofu-potential, intact seed coat and light coloured (clear is most desired) hilum are suitable for these markets. These culinary traits are primarily for tofu, milk, and fermented miso production.

Overall for a variety to be released, it must be a light hila culinary type that matures earlier than the current varieties, have phytophthora root rot resistance, is high yielding, shattering and lodging resistant, have intact seed coat and some weathering tolerance (Andrews and Gaynor, 2000).

## Materials and Methods

The soybean breeding trials were conducted on Vertosols (Isbell 1996), both on LFS and Coleambally. LFS paddock layout consists of 1.5 metre beds on a slope of 1:800. Row spacing were 0.75 metre, with 2 rows of soybeans per bed. Plots were approximately 11 metres long by 3 metres wide (4 rows). Trials consisted of 4 replicated plots per trial, and were sown with a cone seeder into conventional prepare fallow seedbed with parallelogram ground engaging tools. Trials were watered up after sowing. Harvest was either carried by hand or by a Kingaroy Plot Harvester.

Coleambally trials were conducted on permanent 1.8 metre beds, double cropped following a winter cereal crop. Paddocks were watered prior to sowing. At both sites, weeds were controlled by pre-emergent application of Stomp 330EC (Pendimethalin), inter-row cultivation, post-application of Raptor (700g/kg Imazamox) or Spinnaker (700g/kg Imazethapyr) and spot spraying with Glyphosate. Insects were monitored and controlled as per required, using Deltamethrin (27.5g/L).

All seed harvested were cleaned, weighed, tested for various quality traits and then all data analysed by Genstat statistical program. Seed size is determined by weighing 100 dehydrated seeds. Tofu quality, total protein content % and oil content % were tested by CSIRO as per their currently unpublished methods.

## Results and Discussion

**Djakal:** A new soybean variety, Djakal (BAF 212) was released in 2001 for the Riverina region. It was bred by Dr Ian Rose, NSW Agriculture Narrabri, and evaluated and selected by Judith Andrews and Luke Gaynor at YAI.

It matures at least one week earlier than Stephens (+8.5 days) and Curringa (+9.3 days), and nearly two weeks earlier than Bowyer (+13 days), the most commonly grown varieties. It is a light hilum culinary quality variety with a seed size similar to Bowyer and Curringa. While having a slightly lower total protein than these varieties, it has made tofu of quality equal to both Bowyer and Curringa under commercial conditions.

It on average out yields all current varieties and may require one less watering.

**Table 1:** Research trial results at Leeton (6 year average)

Variety	Yield (t/ha)	Days until P95	Hilum Colour
Arunta	3.81	129.0	Black
Stephens	3.80	132.5	Black
Bowyer	3.55	137.0	Yellow
Curringa	3.73	133.3	Yellow
Djakal	3.93	124.0	Buff

Djakal is suited to the southern Riverina and Northern Victoria environment, however care must be taken to avoid planting Djakal into any known *Phytophthora sojae* race 25 paddocks, as under glasshouse laboratory testing it has been shown to be susceptible to this particular race. It is considered to have some level of field tolerance, but to what degree is yet unknown.

If grown as a crushing bean, Djakal would only need protection from insects to prevent yield loss, thus the period for insect control would be less than for food quality beans, where good seed quality requires a longer protection period. Overall when compared to other varieties, Djakal offers advantages in earlier maturity and comparable yield and tofu quality.

## Advanced Trials

The potential of new lines that meet the earlier maturing, light hilum, phytophthora resistant, high yielding and culinary potential criteria has grown significantly in the last two years. The advanced trials at Leeton Field Station have several lines that are in their final stages of evaluations. These lines are currently in their second year of dual site advanced replicated trials. These lines currently under field evaluation have been bred by Dr Andrew James, CSIRO Indooroopilly QLD. Yield data from the 2000-01 advanced trials have not been included below as some varieties appeared (especially early maturity varieties) to be affected more from the Soybean Moth (*Stomopteryx simplexella*) infestation. Huge populations attacked the crop at 2<sup>nd</sup>/3<sup>rd</sup> trifoliolate leaf stage, killing and defoliating many plants. Successful insecticide application of Dimethoate (400ml/ha) and Larvin (750ml/ha) was used to control the soybean moth. Plant populations and overall growth were reduced.

**Table 2:** F8 Advanced trial results for 2001-02 season at Leeton Field Station, MIA.

Line	P95	Maturity relative to Stephens	Maturity relative to Curringa	Seed Size (gms/100 seeds)	Yield T/HA <sup>c</sup>	Oil (DM)	Protein (DM)	Hilum Colour
97016-11 <sup>a</sup>	135	-4	-4	21.5	3.83	17.5	45.9	Clear
STEPHENS <sup>a</sup>	139	0	0	18.5	3.81	18.9	43.4	Black
97016-20 <sup>a</sup>	136	-3	-4	20.0	3.69	17.5	45.6	Buff
DJAKAL <sup>a</sup>	132	-7	-7	20.1	3.68	18.5	42.9	Buff
ARUNTA <sup>a</sup>	136	-3	-3	18.8	3.67	19.0	43.9	Black
CURRINGA <sup>a</sup>	139	1	0	20.4	3.67	18.0	45.8	Buff
97016-23 <sup>a</sup>	139	0	0	18.4	3.64	16.9	46.6	Buff
96245-3 <sup>a</sup>	139	0	-1	22.5	3.62	17.8	45.5	Brown
BOWYER <sup>a</sup>	144	6	5	19.6	3.53	18.3	44.3	Buff
97016-9 <sup>a</sup>	135	-4	-4	19.2	3.48	17.0	46.1	Buff
97016-5 <sup>a</sup>	137	-2	-3	20.2	3.42	17.1	47.2	Buff
BANJALONG <sup>a</sup>	136	-3	-4	18.5	3.40	18.6	45.6	Black
97037-9 <sup>a</sup>	137	-2	-2	20.3	3.38	17.2	46.4	Clear
97037-17 <sup>a</sup>	137	-2	-2	20.2	3.33	17.3	46.8	Clear
97008-9 <sup>a</sup>	134	-5	-5	22.9	3.27	17.8	45.3	Buff
97070-13 <sup>b</sup>	134	-5	-5	21.5	3.18	17.1	47.9	Brown
96245-4 <sup>b</sup>	137	-2	-3	25.1	3.16	17.7	45.3	Clear
97078-2 <sup>b</sup>	133	-6	-6	20.9	3.14	17.8	45.4	Buff
96247-1 <sup>a</sup>	135	-4	-4	23.3	3.09	18.0	45.1	Clear
97008-12 <sup>a</sup>	135	-4	-5	22.3	3.05	17.9	45.9	Buff
LSD (0.05)	2.96	-	-	3.09	566.1	-	-	-

- Sown: 26<sup>th</sup> November 2001
- Harvested: 22<sup>nd</sup> April 2002
- \* @ 13% moisture
- <sup>a</sup> Included in 2002-03 Advanced Trials
- <sup>b</sup> Culled from advanced trials 2002-03
- <sup>c</sup> @ 13% moisture.

**Table 3:** F8 Advanced trial results for 2001-02 season at Coleambally.

Line	P95	Maturity Relative to Stephens	Maturity Relative to Curringa	Seed Size (gms/100 seeds)	Yield T/haC	Oil (DM)	Protein (DM)	Hilum Colour
96245-3	126	-1	-2	21.6	3.43	17.9	45.3	Buff
96245-4	127	-1	-2	23.0	2.77	19.6	42.2	Clear
96247-1	122	-5	-6	20.9	3.33	18.3	44.8	Clear
97008-12	124	-4	-5	20.8	2.63	18.8	43.8	Buff
97008-9	123	-4	-5	20.6	2.97	18.7	42.6	Buff
97016-11	124	-3	-4	19.9	3.59	18.0	44.8	Clear
97016-20	125	-2	-3	18.4	3.39	18.7	43.9	Buff
97016-23	124	-4	-5	17.4	3.10	18.9	43.9	Buff
97016-5	121	-6	-7	18.7	2.80	18.2	44.8	Buff
97016-9	123	-4	-5	17.7	2.91	18.6	44.3	Buff
97037-17	125	-2	-3	19.2	2.79	20.7	39.5	Clear
97037-9	123	-4	-5	19.2	3.25	18.9	42.7	Clear
97070-13	126	-1	-2	17.8	2.40	20.8	39.4	Brown
97078-2	123	-4	-5	20.5	2.96	18.0	45.0	Buff
Arunta	127	-1	-2	16.6	3.28	18.1	45.2	Black
Banjalong	127	0	-1	17.3	2.63	18.7	43.9	Black
Bowyer	134	7	6	18.3	2.45	19.9	39.8	Buff
Curringa	128	1	0	19.1	2.80	18.3	44.7	Buff
Djakal	122	-5	-6	18.0	3.05	18.6	44.0	Buff
Stephens	127	0	-1	16.5	3.07	18.9	43.0	Black
LSD @0.05	2.74			0.7958	0.664	0.3	0.6	

- Sown: 5<sup>th</sup> December 2001
- Harvested: 17<sup>th</sup> April 2002
- \* @ 13% moisture
- <sup>c</sup> @ 13% moisture.

The cross 97016 have consistently yielded above average in the last two seasons. It has displayed an early maturity and high yields when compared to current varieties. 97016-11 in 2001-02 yielded top of both advanced trials at LFS and Coleambally. It has an excellent phytophthora rating, having total resistance to races 15 & 25 (most prevalent races) that no other current variety offers. This will allow wide spread planting in areas known to have race 25 if released. The maturity of 97016-11 is about 3 days later than Djakal, but still earlier than Stephens, Curringa, and Bowyer (4, 4.5 and 9 days respectively). It is large seeded, clear hilum and has excellent protein content. With the parents been Arunta over Harovinton, 97016-11 through testing by CSIRO Indooroopilly, has proven to have high gelling ability and the ability to produce tofu of a high quality. 97016-11 is currently still under field testing.

The lines, 97016-20 and 97016-23 are from the same cross as 97016-11. They both have very similar agronomic characteristics, albeit they have a buff hilum, slightly less yield and but generally equal tofu qualities. These lines are also included in this year's advanced trial.

This season advanced trials consist of 22 treatments, including 7 of these being commercially available varieties (Arunta, Banjalong, Bowyer, Curringa, Djakal, Stephens and Empyle). These trials also included 96247-9, 96248-23 and 97008-10 that are three promising lines from the Northern Victoria Breeding Program. The trials are located at Coleambally and LFS, with LFS having two sowing dates (3<sup>rd</sup>/4<sup>th</sup> week of November & 2<sup>nd</sup> week of December). Other trials include F7 (22 treatments), F6 (120 treatments), F5 (230 treatments), and 2 sowing rate trials (coinciding with F8 advanced sowing dates).

### **Conclusion**

The emphasis of the breeding program is to produce varieties that have a significant earlier maturity, phytophthora *sojae* disease resistance, high yielding and meets the seed quality standard of the culinary markets. The southern irrigated areas of NSW should therefore become with better varieties, the principal area for production of high quality light hilum culinary soybeans. Currently, in the advanced trials and early generation trials we have varieties that are meeting these requirements. Many lines have at least one recognised culinary parent. This season large areas of breeder's seed have been planted of lines that have the potential for release in the near future, and that meet all agronomic and culinary requirements. This will enable large quantities of seed to be available to farmers once a new variety is released. Once better varieties are available to growers, the only limitation for producing consistently high quality light hilum culinary soybeans will be insect control, in particular *Nezara viridula* (Green Vegetable Bug). More R & D needs to be carried out in this area to reduce this pest impact on seed quality and help farmers take full advantage culinary markets and premium prices paid for high quality soybeans.

With the current drought conditions throughout the state and cropping regions, the importance of days to maturity and water use efficiencies of the crop are high on the priority list and will continue to be so with the future water reforms.

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