NSW DEPARTMENT OF PRIMARY INDUSTRIES

SOYBEAN: North Coast NSW Planting Guide

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In the rain-grown environment of the North Coast of New South Wales (NSW), achieving consistently high soybean yields requires careful consideration of a range of crop management aspects. These are dealt with in depth in the publication *Soybeans* (Agfact P5.2.6, second edition August 1995). Details of suitable varieties and appropriate sowing dates for each of these varieties needs to be updated regularly as new varieties become available and older varieties are superseded.

This guide contains topical information and seasonal reminders of some of the more critical aspects of soybean crop management. It also deals with major issues that have arisen since the previous Planting Guide or Agfact. It includes details of the latest variety recommendations for the environment of the NSW North Coast.

On the North Coast of NSW, soybeans are grown mainly in the Clarence and Richmond valleys, but soybean crops are also grown as far south as the Manning Valley. The crop is grown on better class alluvial soils, on mixed soil types in rotation with sugarcane (Figure 1), on lighter textured hill soils in pasture development programs and in rotation with winter and summer cereal crops.

Crop check guides for soybeans targeting best management practices have been developed for the North Coast and are best utilised in consultation with your crop advisor. Traditionally this area has produced soybeans for the crushing market. However, in recent years there has been a gradual swing to clear or colourless hilum soybean varieties for the human consumption market, which places more emphasis on grain quality. The Australian Oilseeds Federation (AOF) publication *Australian oilseeds grower quality guide* outlines specific strategies for growers targeting human consumption soybean markets. In addition to hilum

Figure 1. A well-managed crop of Cowrie in a sugarcane rotation

colour, varieties grown for human consumption markets, such as soyflour, soymilk or tofu, have particular grain specifications. These are set by the National Agricultural Commodities Marketing Association (NACMA) and published on the AOF website (www.australianoilseeds.com). Receival standards are available through the GrainCorp website (www.graincorp.com.au).

VARIETIES

Recommendations are based on extensive testing of new and currently grown varieties. Characteristics important in a soybean variety well adapted to coastal environments and soils include:

- tolerance to high soil manganese levels, common in soils with low pH
- weathering tolerance at harvest
- tolerance to sclerotinia stem disease
- tolerance to downy mildew leaf disease
- tolerance to phytophthora root rot (not a common problem in the North Coast region to date)
- consistently high yield and protein content
- good mature plant height (80–100 cm) for the relevant sowing time without lodging.

Soybean commence flowering in response to shortening daylight hours, which then has an effect on the time to maturity, mature plant height and yield. Selection of an appropriate variety and a suitable sowing date are important factors for a high yielding crop. If a variety is sown earlier than recommended it will grow too tall before flowering and probably lodge, thereby reducing yield and creating a more favourable environment for disease to develop. If sown later than recommended, yield will be reduced and the crop will be too short and therefore difficult to harvest.

Figure 2 shows the recommended varieties for the Far North (Northern Rivers) and Mid North Coast areas of NSW. A wide range of varieties is necessary as sowing in the region is dictated by when rain falls. For each recommended variety in Figure 2, some distinguishing features and ratings for diseases, weathering and manganese are shown in Table 1.

VARIETY DESCRIPTIONS

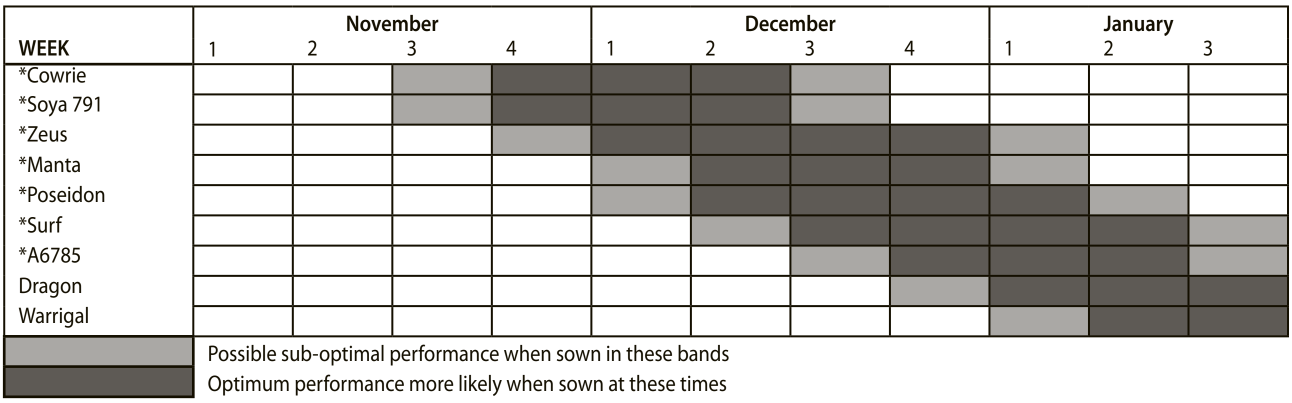
An approximation of seed size is given for culinary varieties only and is at 12% moisture.

Cowrie was released in 2002 by NSW DPI for northern NSW, including rain-grown coastal and inland irrigation areas. It has a colourless (clear) hilum (Figure 3), good protein content and large seed size (approx. 23 g/100 seeds), making it very acceptable to the soymilk and soyflour markets. Weathering tolerance is moderate (70% of Zeus). Cowrie is tolerant to race 1 of the root rot pathogen *Phytophthora* but not to race 15.

Soya 791 has a buff hilum and is suited to soyflour production. It is also used for soymilk, although seed size (approx. 21 g/100 seeds) is a little smaller than is preferred for this market. It can produce high yields if sown at the correct time and has moderate weathering tolerance and good protein content. Soya 791 is tolerant to race 1 of *Phytophthora* but not race 15, and has poor tolerance to the white mould fungus *Sclerotinia*. It is susceptible to manganese toxicity.

Figure 2. Sowing dates for regions of North Coast NSW (* denotes recommended varieties)

Far North Coast – Northern Rivers (Clarence, Richmond and Tweed)



Mid North Coast – Manning, Hastings and Macleay rivers

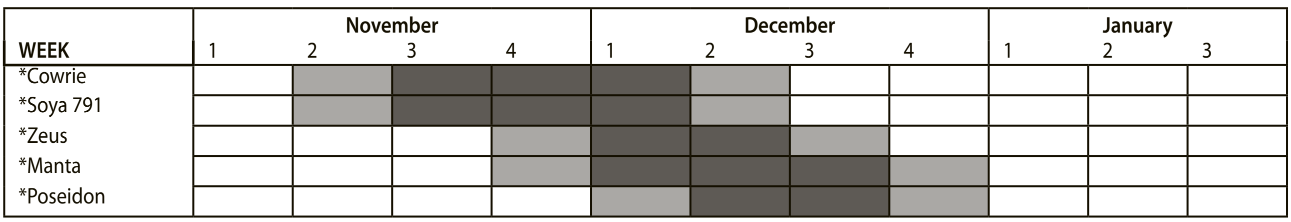


Table 1. Varietal features

	Colour			Tolerance to				
	Flower	Pod hair	Hilum	Manganese	Weathering[A] (0–10)	*Phytophthora*[B] race 1	*Phytophthora*[B] race15	*Sclerotinia*[B]
Cowrie	white	grey	clear	++	7	✓	x	unknown
Soya 791	white	grey	buff	0	7	✓	x	+
Zeus	purple	brown	dark	++	10	✓	x	+++
Manta	purple	brown	dark	++	8	✓	x	+++
Poseidon	purple	brown	dark	++	8	✓	✓	+
Surf	purple	grey	clear	unknown	6.5	✓	✓	unknown
A6785	white	grey	buff	unknown	7.5	✓	✓	unknown
Dragon	white	grey	buff	unknown	0	✓	✓	unknown
Warrigal	white	grey	clear	0	2.5	✓	✓	0

+ indicates tolerance scale, more crosses indicate higher tolerance, 0 = susceptible

[A] based on controlled environment weathering assessments, NSW DPI Grafton, NSW. 10 = highest weathering tolerance

[B] based on disease assessments and field observations by Dr Malcolm Ryley, DPI&F, Qld

(grey shading) indicates a significant weakness in this variety

Zeus was bred by NSW DPI for northern coastal NSW environments and was released in 1999 as a higher yielding and more weathering tolerant replacement for Dune. Zeus has the highest level of weathering tolerance of all the current commercially available varieties and useful levels of tolerance to sclerotinia, which makes it a popular choice for areas with high rainfall and humidity. Zeus has a dark coloured hilum and is therefore suitable only for the crushing market.

Manta was released in 1991 by NSW DPI for coastal environments. This variety combines high yield, tolerance to manganese, sclerotinia and race 1 of *Phytophthora*. It also has a good level of weathering tolerance. Manta produces grain with above average protein content, but is only suitable for the crushing market due to its dark coloured hilum.

Poseidon was bred by NSW DPI for northern coastal NSW and released as a public variety in 1999 as a higher yielding replacement for Manta. Weathering tolerance and protein content are similar to Manta. Tolerance to sclerotinia is less than in Manta. Poseidon has good tolerance to race 15 of *Phytophthora*. It has a black hilum, which makes it suitable only for the crushing market.

Surf was released as a public variety by NSW DPI in 2004 (Figure 3). It was derived from a single plant selected from trials conducted at Grafton by NSW DPI. It differs in many characteristics to the plants in which the single plant was found (PKM120). It has a clear hilum, large seed size (approx. 22 g/100 seeds) and good protein content, making it suitable for the culinary market. Surf will extend the planting window for culinary soybean varieties on the North Coast of NSW, which is currently

Figure 3. Surf (right) and Cowrie (inset) are clear hilum, culinary (edible) varieties released by NSW Department of Primary Industries and the National Soybean Improvement Program

only served by Cowrie and Soya 791 at earlier sowing dates. Surf has a similar weathering tolerance to Cowrie and is tolerant to races 1 and 15 of *Phytophthora*.

A6785 (Asgrow) has a buff hilum and is suited to soyflour production and is sometimes used in soymilk manufacturing, although seed size (approx. 18 g/100 seeds) is smaller than is preferred for this market. It produces high yields if sown at the correct time and has tolerance to races 1 and 15 of *Phytophthora*, moderate weathering tolerance and moderate protein content. In trials on the North Coast of NSW, A6785 has tended to lodge when sown too early.

Dragon was not bred specifically for the coastal environments of the North Coast of NSW and has very poor weathering tolerance, which can present a problem if rainy conditions occur at harvest. It is tolerant to races 1 and 15 of *Phytophthora*. Although it has a buff coloured hilum, Dragon has large seeds (approx. 23 g/100 seeds) and is often used for soymilk.

Warrigal was developed by the Qld DPI&F and is marketed under the protection of Plant Breeders Rights. It has a colourless hilum and is tolerant to races 1 and 15 of *Phytophthora*. Warrigal has some application in northern NSW particularly where a late-planted, clear hilum variety, with larger seed size (approx. 21 g/100 seeds) is required. However, Warrigal is highly susceptible to sclerotinia, which can be a problem in late flowering crops and is favoured by dense canopies and humid conditions. It also has poor weathering tolerance, which may present a problem if extended wet conditions occur at harvest. It is also susceptible to manganese toxicity.

PLANTING GUIDE

A summary of critical targets in the soybean crop cycle is shown in Figure 4.

Target 1 Planting Sow appropriate variety at correct planting time, 3 to 5 cm deep into good soil moisture.

Target 2 Emergence 7 days. Uniform stand of 30–40 plants per square metre. Check for insects, weeds and diseases.

Target 3 Early vegetative 1–5 weeks. Check weekly for weeds, insects, look for tip and leaf damage, and root and stem disease. If weeds present, DO post-emergent weed control before the crop canopy closes.

Target 4 Late vegetative 5–6 weeks. Check nodulation, more than 10 root nodules per plant with red/pink colour inside.

Target 5 Flowering 6–7 weeks. Weed free crop 60–100 cm high with complete canopy cover. Once flowering commences check every 3 days for insects and for leaf and stem disease. Visually assess for any nutritional problems.

Target 6 Podding Commences 8–10 weeks. Monitor and control insects, check every 3 days for insects, also check for leaf and stem disease.

Target 7 Physiological maturity 14–16 weeks. 50% of pods brown/tan, seed no longer attached to pod wall. Leaf drop commences approx. 16 weeks.

Target 8 Harvest 18–20 weeks 95% pods brown/tan, grain 15% to 18% moisture.

NOTE: This is a guide only. Growth stages can vary depending on variety, sowing date and extreme environmental conditions.

Sowing time

Soybean plants flower and mature in response to shortening length of daylight. Current commercial soybean varieties are photosensitive and in general the later they are sown the fewer days until flowering. If the same variety is sown on the same day at Casino and Wauchope, it experiences longer summer days at Wauchope and so flowering begins a little later.

If varieties are sown outside their recommended period, less than optimum performance is the likely result.

Varieties sown later than the recommended sowing time will likely have shorter plants with pods set closer to the ground. Conversely varieties sown earlier than recommended can spend too long in the vegetative phase, grow too tall and lodge.

In the Manning, Hastings and Macleay valleys, the range of recommended sowing times are from early November to the end of December (see Figure 2).

In the Northern Rivers districts of NSW, available varieties allow sowing from late November to about 20 January. Within this range each variety has an optimum sowing period of two to three

Figure 4. Soybean crop growth targets (adapted from SoyCheck 1997)

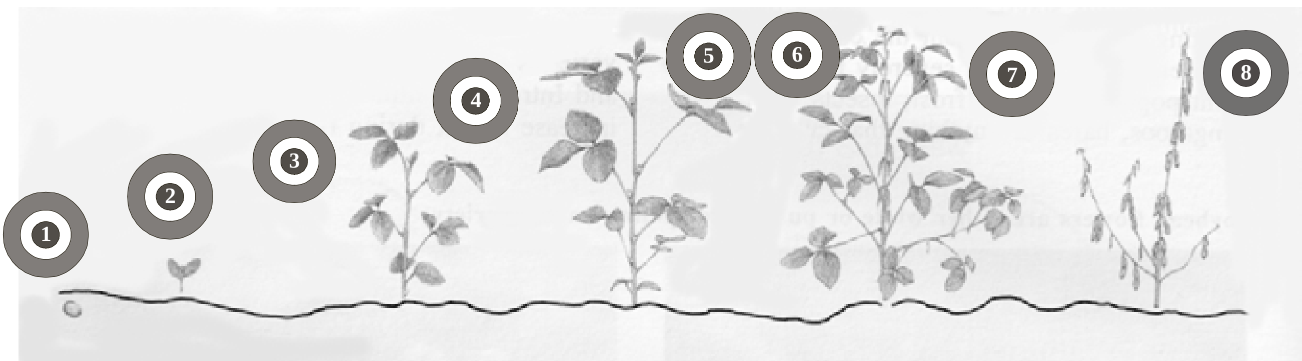


Figure 5 . Use of press wheels (above) assists establishment in no-till situations (right).

weeks (see Figure 2). Sow in the early part of the recommended period where early growth is likely to be slower, such as where soil fertility is low, moisture is limiting or where crops are direct drilled.

Sowing methods

In cultivated soils, seed is generally sown in 18 or 36 cm wide rows using conventional seed drills. With minimum or no-till systems, specialised direct drills are necessary to ensure uniform seed placement and clearance of pasture residue or crop stubble (see Figure 5).

In high yielding situations, row spacings less than 75 cm outyield wider row spacings. Row cropping has economic advantages in allowing the use of banded sprays, shielded sprays and inter-row cultivation for weed control. It also facilitates the use of penetrating directed sprays for insect control and the precision placement of seed at sowing. Establishment of precision planted row crops is often superior to combine sown crops.

Wide rows aligned to the direction of the prevailing winds can reduce the incidence of sclerotinia by reducing humidity in the crop. However, overall crop management has a far greater influence on yield than row spacing.

At sowing, seed should be placed into moist soil to a depth of not more than 5 cm. Where moisture is deeper than this, drilling to 7.5 cm has been successful but emergence can be poor, particularly if heavy rain causes the soil to pack or crust before seedlings emerge. The use of rollers is generally not advised. Planters with press-wheels which press the soil onto the sides of the seeds whilst leaving a crown of uncompacted soil for easy seedling emergence are preferred.

Plant population

For narrow rows, the optimum plant population is between 300 000 and 400 000 plants per hectare. For wide rows, aim for 280 000 to 320 000 plants per hectare. Lower plant populations are acceptable when sowing is early, while higher densities are preferred for sowings later in the recommended period.

Seed quality

Don't be caught with low quality planting seed. Soybean seeds are relatively short-lived and even when produced under optimum conditions can lose germination and vigour after a few months in storage.

Prolonged wet weather before harvest reduces seed quality by the alternate wetting and drying of seed in the pods. Seed with high moisture levels will lose germination capacity after only a few months storage.

Soybean seeds have a thin seedcoat, making them more susceptible to damage than other crop species. Incorrect seed handling, the use of spiral augers, and long drops of seed onto hard surfaces will damage the thin seedcoat and reduce the amount of viable seed. Larger-seeded types, grown for human consumption markets, are at greater risk of mechanical damage than the smaller-seeded crushing types.

Obtain a reliable germination test after harvest to make sure seed is worth keeping and test it again before sowing to ensure it has not deteriorated. Germination tests cost $30 to $50 per sample. Seed testing laboratories are listed at the end of this publication.

Good quality seed will have germination test levels of 90% or greater. Germination test results below 80% generally indicate seed with poor vigour, which should be avoided if possible. When calibrating seeders the following formula can be used:

Seeds to drop per linear m of row =

$$\frac{\text{row spacing (m) x targeted plant population (plants/ha)}}{\text{seed germination \% x establishment rate \% of germinative seed}}$$

Fertilisation, inoculation and liming

When deciding how much fertiliser to apply to a soybean crop it is important to know the nutrient status of the soil and the critical level of soil nutrients, particularly phosphorus and potassium that

Table 2. Approximate nutrient utilisation of a 2.5 t/ha soybean crop

Plant part	Plant nutrient (kg/ha)			
	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Sulfur (S)
Total plant uptake	230	17	123	14.5
In seed only	167	14.5	48	11.5

NOTE: This table should not be used as a direct indicator of crop fertiliser requirements, but it is a useful guide to P and K soil maintenance requirements – an important consideration for low fertility soils.

are needed to give the maximum economic yield. A soil test is the best way to determine soil nutrient status.

Soybeans have a high demand for plant nutrients. The approximate quantities of major nutrients utilised by a soybean grain crop are shown in Table 2.

NOTE: This table should not be used as a direct indicator of crop fertiliser requirements, but it is a useful guide to P and K soil maintenance requirements – an important consideration for low fertility soils.

Nitrogen (N) Once established nitrogen fixing bacteria (rhizobia) in the root nodules will supply soybean plants with all their nitrogen requirements. There are no native soybean rhizobia in Australia capable of effectively causing nodulation in soybeans. Selected rhizobia in Group H are introduced to soybean fields by:

- inoculation of seed by coating with a slurry or liquid inoculant before planting
- mixing dry peat inoculum with seed
- injecting liquid inoculant onto the seed at planting
- dispensing a granular inoculant with the seed at planting.

A small amount (up to about 15 kg of N per hectare) of 'starter' nitrogen may be beneficial in certain situations. For example, for late sown crops it helps to ensure good early growth of seedlings and adequate lower pod height for harvest. Small amounts of starter N may also be beneficial where soybean is sown into dense sugar cane stubble. Care must be taken not to apply too much starter N as this will have a detrimental effect on the establishment of nodules that supply nitrogen to the plant later in the crop cycle.

Molybdenum (Mo) Root nodule bacteria require molybdenum as part of an enzyme to convert atmospheric nitrogen to a form that is used by the plant. Most soils on the North Coast of NSW are acidic and deficient in plant available molybdenum. Fifty grams of Mo/ha is sufficient for two consecutive soybean crops. Mo is usually applied as a seed dressing of molybdenum trioxide (60% Mo) or Mo Superphosphate (commonly 0.025% Mo). Sodium molybdate and ammonium molybdate are toxic to inoculant rhizobia.

Phosphorus (P) Phosphorus fertiliser is required for good production on most coastal soils. Soils predominantly derived from sedimentary rocks are extremely low in phosphorus and high rates of phosphatic fertiliser are required for economic yields.

The heavy clay flood plain soils of the Richmond Valley have high levels of reactive iron (that fixes phosphorus). In these types of soils, a large proportion of the phosphorus applied in fertiliser can be fixed in a form that is unavailable to the current crop. Phosphorus drilled with or banded close to the seed is the most effective way to supply this nutrient to the soybean plant, particularly in soils with high phosphorus buffering indices.

On podsolic soils where large amounts of superphosphate are required, apply up to 200 kg/ha with the seed when combine sowing, with the balance applied pre-sowing.

Table 3. Guide to phosphorus fertiliser requirements for soybean crops on North Coast soils

Extractable phosphorus (mg/kg)			Phosphorus recommendation (kg/ha)	
Colwell test		Bray No.1 test	Phosphorus	Single Super
PBI* < 280 e.g. sandstone/shale/ granite	PBI > 280 e.g. basalt/ clay alluvials	All soils		
0–10	0–30	0–5	35–44	400–500
11–15	30–40	5–10	26–35	300–400
16–25	40–50	10–15	13–26	150–300
26–40	50–60	15–25	5–13	60–150
Over 40	Over 60	Over 25	5	60

* Phosphorus Buffering Index (Burkitt *et al.* 2002)

Table 4. Potassium fertiliser recommendations for soybean crops on North Coast soils

Exchangeable potassium levels. K recommendation as muriate of potash		
C mol+/kg	K (kg/ha)	muriate of potash (kg/ha)
0–0.1	50–75	100–150
0.1–0.2	25–50	50–100
0.2–0.4	10–25	20–50
Over 0.4	Nil	Nil

For practical and economic reasons, most growers with medium to high phosphorus soils broadcast and incorporate the entire fertiliser requirement prior to sowing.

When direct drilling with minimal soil disturbance (e.g. triple disc), apply up to 100 kg/ha superphosphate with the seed and surface broadcast the balance. Use Table 3 as a guide to soybean crop phosphorus fertiliser requirements.

Potassium (K) Soybean yields may be limited by potassium deficiencies on some coastal soils, particularly on sandy soils and those with a long history of intensive cropping where heavy export of K in hay, silage, grain or sugarcane has occurred. Table 4 gives a guide to potassium fertiliser requirements for North Coast soybean crops.

Potassium is deficient on heavy montmorillonite based clay soils, when exchangeable K is less than 1% of the total cation exchange capacity, irrespective of the absolute exchangeable potassium value.

When sowing, never place any potassic fertiliser in contact with the seed, as plant establishment will be impaired by the salt effect of the fertiliser.

Sulfur (S) Soybeans are a high protein legume and insufficient sulfur limits yield. Generally, superphosphate applications supply adequate sulfur. On high phosphorus testing chocolate basalts of the Kyogle district, inadequate sulfur can frequently limit yields, especially with direct drilled crops. The KCl-40 soil test is a good guide for sulfur fertiliser requirements. If KCl-40 S test levels are below 10 mg/kg, apply sulfur at rates up to 15 kg/ha.

Trace elements Except for molybdenum, fertiliser trace elements are generally not required for soybean crops on the North Coast of NSW. Copper and zinc can be deficient for pastures and sugar cane on sandy Wallum soils.

Soil acidity and liming

Soybean plants are adapted to acid soils and prefer pH ($CaCl_2$) levels from 5.2–6.5. As pH levels drop below 5, increasing amounts of toxic aluminium enter the soil solution. This effect is common in the soils of the North Coast of NSW and is greatest in soils that are low in organic matter as indicated by an organic carbon soil test. Soils with pH levels of 4.5 or less are unsuitable for growing soybeans.

Figure 6. Symptoms of manganese toxicity in soybean seedlings after waterlogging

Moderately acid soils can release potentially toxic soluble manganese after a waterlogging event (see Figure 6). Also, the heating effect on exposed soils releases soluble manganese. Liming raises the pH and reduces the intensity and duration of the soluble manganese pulse.

Where manganese problems are likely to occur:

- improve drainage
- incorporate lime
- grow manganese tolerant soybean varieties (see Table 1).

All intensive agriculture is acidifying and a lime requirement must be 'factored in' as an essential input for a sustainable cropping system. Soybean plants leave a nitrogen rich residue which breaks down to nitrate and becomes available to the following crop. When nitrates are leached, the zone of leaching becomes more acid. In general terms, for maintenance incorporate lime at 1 t/ha every five years to maintain pH on lighter and heavier textured soils.

For soybeans keep aluminium saturation levels less than 15% and manganese less than 20 mg/kg. If barley is also grown, depending on variety, keep aluminium saturation levels below 5% and manganese less than 50 mg/kg. For a pH below 5 where aluminium and manganese are at toxic levels, apply up to 2.5 t/ha of lime and monitor pH change with soil tests.

Lime and all other fertiliser decisions should be based on soil test results from an accredited testing laboratory.

Fertilisers in organic production systems

The National Standard for Organic and Bio-dynamic Produce was established by the Australian Government. Accredited certifying organisations apply this standard as a minimum requirement to all products produced by farmers certified under their inspection system. A list of approved inputs is available from the various certifying organisations.

In general, most conventional liming materials are approved as well as rock phosphate, phosphatic guano, potash (rock and sulfate potash), elemental sulfur and natural gypsum.

Animal manures from non-certified farms must be composted to strict standards. Composted animal manures and approved waste products from livestock processing can provide a wide range of major and micro nutrients for soybean production.

Beneficial soil micro-organisms are used to increase the availability of plant nutrients. Liming increases the availability of molybdenum and reduces the effects of manganese toxicity.

WEED MANAGEMENT

Weeds compete with soybeans for moisture, nutrients and light; and can create difficulties at harvest. Weed contamination of the crop can drastically reduce grain yield and increase harvest costs. Additional costs may be incurred if weed seeds have to be graded out of the harvested grain. In the worst cases, prolific growth of troublesome weeds such as Apple of Peru (*Nicandra physalodes*), Jute (*Corchorus* spp.), Bellvine (*Ipomoea plebeia*) or Sesbania pea (*Sesbania cannabina*) can even prevent harvest.

Adverse effects of weeds on soybean yield are determined by:

- weed – species, density and duration of competition
- crop – vigour, density and planting configuration.

Weed control starts with a program to prevent a bank of weed seeds in the soil. Since no single herbicide will control all weeds, growers should be conscious of the importance of crop rotations and pasture leys. For example, rotation with maize allows the use of a range of herbicides to control the difficult to kill broadleaf weeds of soybean crops.

A weed-free fallow is essential for weed control and conservation of moisture. With conventional cultivation a weed-free seedbed is best achieved with an early working and follow-up cultivations to help kill weeds and remove new seedlings. In no-till and reduced-till crops, herbicide sprays are used as alternatives to cultivations.

Development of a dense canopy is the key to reducing the effects of weeds germinating later in the season. Row cropping allows inter-row cultivations before canopy closure, but wet weather can interfere with correct timing. Organic growers need to use inter-row cultivation to control weeds, but will often need to employ a team of chippers to remove weeds in the plant row.

Table 5. The effect of row spacing in the presence or absence of weeds, on soybean yield (Felton 1976)

Row spacing	Soybean yield		Reduction in yield
	- weeds	+ weeds	
cm	kg/ha		%
25	3084	3065	<1
50	3018	2419	20
75	3078	2288	26
100	2964	1861	37

Development of a dense canopy is encouraged by:

- a good seedbed with adequate moisture and good seed to soil contact
- the use of high germination/high vigour seed, along with adequate fertiliser application
- sowing the recommended soybean variety on time.

Sowing too deep (greater than 5 cm), compacted/crusted soil, waterlogged soil and/or soybean diseases are examples of factors that can reduce establishment and increase weed competition.

Early canopy closure is best achieved by sowing in narrow rows. The effects of row spacing on the presence or absence of weeds and soybean yield are shown in Table 5.

Where weeds occur there are distinct advantages in growing soybeans at the higher range of recommended plant densities and reducing the inter-row spacing. Increasing plant population for weed competition may result in plants with thin, weak stems, predisposing the crop to lodging.

Weed competition is more severe in wide row crops, where control has been delayed. In narrow row crops, any delay in herbicide application may result in poor coverage of the target weed. Wide rows allow inter-row cultivation and low cost band spraying of rows.

Count on one opportunity to establish the targeted plant population. Gaps in crops allow weeds to flourish.

Soybeans are most sensitive to weed competition four to seven weeks after emergence. Extreme grass competition can affect soybean yields much earlier, especially if conditions are dry.

Tall growing weeds (Apple of Peru, Gooseberries) that push through the crop canopy can shade the crop, causing leaf fall and straggly weak stemmed plants with low pod counts. Under cool humid conditions these crops are more subject to sclerotinia.

Conventionally grown crops

A range of herbicides registered for weed control in soybeans are shown in Table 6.

Pre-emergent herbicides

Under conventional cultivation, with a good fine seedbed, grass weeds are more economically controlled with soil-incorporated pre-emergent herbicides. Trifluralin and pendimethalin products are soil incorporated and need a good seedbed free from large clods (grass seeds inside clods can germinate, establish and survive after rain 'melts' clods). Metolachlor products such as Dual Gold are best surface applied immediately post planting. Metolachlor has limited activity on broadleaf weeds.

Table 6. Commonly used herbicides registered for weed control in soybeans

Situation	Weed	Herbicide	Product example	Rate L/ha
Pre-plant	Annual grasses and some broadleaf	Trifluralin	Treflan	1.4–2.1
		Pendimethalin	Stomp 330E	2.5–3.0
Post-plant, pre-emergent	Annual broadleaf and some annual grasses	Imazethapyr	Spinnaker 700 WDG	(0.1–0.14 kg) + wetter or crop oil
	Annual grasses	S-Metolachlor 960	Dual Gold	1.0–2.0
Post-emergent	Annual broadleaf and some grasses	Imazethapyr	Spinnaker 700 WDG	(0.1–0.14 kg) + wetter or crop oil
	Grasses	Quizalofop	Targa	0.25–0.375
	Grasses	Haloxyfop	Verdict 520	0.1–0.15
	Grasses	Butoxydim	Falcon	120–180 g + wetter
	Grasses	Fluazifop	Fusilade	0.5–1.0 + wetter
	Grasses	Clethoxydim	Select	0.25–0.375
	Grasses	Sethoxydim	Sertin	1.0 + 1.0–2.0 crop oil
	Broadleaf	Bentazone	Basagran	1.5–2.0
	Broadleaf	Acifluorfen	Blazer	1.0–2.0

Some broadleaf weeds, nut grass and barnyard grass can be controlled with a pre-emergent application of Spinnaker 700 WDG herbicide, surface applied immediately post planting. Rainfall is required for incorporation.

Post-emergent herbicides

Grasses and broadleaf weeds can also be controlled post-emergence, preferably in the fourth week after emergence. A delayed spray may result in greater yield loss through impaired coverage of the weed by herbicides. Best results are obtained on weeds less than four leaf stage.

Post-emergent broadleaf weeds may be controlled with Spinnaker, Basagran or Blazer (see Tables 6 and 7). Mixtures of Basagran and Blazer are permitted.

Post-emergent grass herbicides are most effective on actively growing grasses at the three to five leaf stage before tillering commences (see Table 6).

Herbicides for controlling weeds in direct drilled soybeans

With direct drilled soybeans, glyphosate herbicides and other products replace cultivations. Pre-conditioning the soil with a prior winter cereal crop greatly assists the rapid establishment of direct drill soybeans, a most important factor in controlling weeds.

If serious grass weeds are anticipated, metolachlor can be applied with glyphosate prior to planting or it can be surface applied alone immediately post-planting and before weeds have germinated. For metolachlor to work effectively, rain is

Table 7. Herbicides registered for post-emergent broadleaf weed control - L/ha

Weed	Blazer	Basagran	Spinnaker 700 WDG
Amaranthus	1.5–2.0		0.1 kg + wetter
Annual Ground Cherry	1.0–2.0	2.0	
Apple of Peru		2.0	0.14 kg + wetter
Bellvine	1.5–2.0	2.0	0.1 kg + wetter
Blackberry Nightshade	2.0	2.0(S)	
Bladder Ketmia	2.0		0.14 kg + wetter
Cobblers' Pegs (Farmers' Friends)		2.0	
Fat Hen			0.14 kg + wetter
Jute	1.5–2.0		0.1 kg + wetter
Noogoora Burr	2.0		0.14 kg +wetter
Nutgrass			0.14 kg + wetter
Sesbania Pea	2.0		
Thornapple	1.5–2.0	1.5–2.0	0.1 kg + wetter
Wild Gooseberry	1.0–2.0		0.1 kg + wetter
Paddy's Lucerne		*	
Annual Ragweed	*		*

(S) - suppression
* For recommendations contact chemical company representatives.

necessary within 10 days of spraying to thoroughly wet the top 3–4 cm of soil.

For broadleaf weed control, Spinnaker can be surface applied immediately post sowing. To activate Spinnaker, rain is required prior to weed emergence to wet the soil to a depth of 5 cm.

Many soybean growers who use direct drill systems apply two spaced glyphosate sprays before sowing and follow-up later with a post-emergent grass and/or broadleaf herbicide.

Harvest-aid herbicides

When green weeds contaminate crops and are likely to cause difficulties in harvesting or cause seed quality downgrading, a salvage spray to desiccate weeds is necessary.

- Diquat is applied when 80% of pods are yellow/brown and seeds are ripe, yellow and pliable. Harvest 4–7 days after spraying.
- Roundup PowerMAX is applied only after seed pods have lost all green coloration and 80%–90% of leaves have dropped. Do not apply to crops grown for seed or sprouting. Do not harvest within seven days of application.

Important pointers for effective herbicide use

Getting the most out of herbicides depends on several factors:

- As a general rule, ground rig application is more effective than aerial application.
- Read the herbicide label carefully for details on optimum application methods and optimum conditions for spraying.
- Be aware that weeds can become resistant to herbicides if they are not used as recommended. Practise good crop rotations, rotate herbicide groups and combine chemical and non-chemical weed control methods to reduce the chance of weeds developing resistance.

Managing weeds in organically grown crops

A clean fallow with a shallow cultivation to kill emerged weeds immediately before planting gives the crop a good start. A vigorous even crop established at the optimum plant population in narrow rows assists early canopy closure and ensures maximum competition to late establishing weeds.

Row spacings of 75 cm are commonly used on the North Coast of NSW. Row spacings as narrow as 37.5 cm have been used but inter-row cultivation requires greater precision. Row spacings of 50 cm are ideal and result in earlier canopy closure than rows spaced at 75 cm.

Weeds have a large impact on reducing soybean yields during the first 40 days of crop development. Inter-row cultivators with shields to protect soybean seedlings against mechanical damage are used from the 1–3 trifoliate leaf stage. Shallow inter-row cultivation or 'scuffling' can be done up until there is a risk of physically damaging the crop.

There are no effective harvest-aid sprays to desiccate weeds that are acceptable for organically grown crops. Weeds that establish between the plants in a row must be removed by hand.

Crop rotation provides some benefits in controlling weeds. Maize growing allows more aggressive scuffling as maize plants will tolerate greater amounts of soil thrown around the stems, for smothering very small weeds.

The use of perennial pasture leys can reduce weed seed levels in the soil and restore soil structure. High density, warm-season forage crops can be used to smother weeds. Slashing after grazing can prevent weeds from producing seed.

INSECT PESTS

Monitor and identify insects in the crop

No season is identical in respect to the development of insect populations in plant crops. Different insects reach different population levels each season. The range of factors for this are not completely understood. Regular checking of the crop is crucial to understand the changing populations of insects that develop throughout the season, to become familiar with pest management thresholds, and to enable early detection and identification of new pests before significant damage occurs.

It is strongly recommended that growers become familiar with the few pest and many beneficial insects that inhabit soybean crops, in order to make informed decisions about insect pest management. In particular soybean crops should be inspected carefully for insect pests at the beginning of the following growth stages:

- emergence
- mid-vegetative growth
- flowering
- pod elongation
- pod filling.

Control infestations at these times if insects are accurately identified and are in sufficient numbers to cause significant plant or yield loss. Growers targeting high quality tofu and milk markets should be aware of lower insect damage thresholds in seed for these markets.

Coastal soybean crops may be affected by a range of insect pests at all stages of development. Growers should check crops every five days prior to flowering and once every three days from flowering until pods start to yellow. Knowledge of integrated pest management (IPM) practices is essential, especially in relation to controlling pests such as silverleaf whitefly B-biotype (see Table 8).

Table 8 lists the main insect pests of coastal soybean crops and provides general information on 'action thresholds' for control by pesticides. Selection of pest-specific pesticides and pesticides

Table 8. Some of the common insect pests of coastal soybean crops

Pest	Comments	Action threshold (guide only)
Seedling pests		
Cutworms	Spray late afternoon or evening.	Small uniform seedling losses of up to 15% can be tolerated for early sown crops.
White fringed weevil	Larvae eat roots. Adults can defoliate seedlings.	Sporadic occurrence. No threshold determined.
Foliage feeding caterpillars		
Cluster caterpillar	A sporadic foliage feeder.	Foliage damage thresholds as for *Helicoverpa*.
Grass blue butterfly larvae	Larvae feed on terminals, axillary buds and leaves.	Crops can tolerate the loss of 50% of the terminal growing points without yield loss. When moisture stressed the tolerance drops to 20%.
Helicoverpa spp. (heliothis)	Damage foliage, flower buds, flowers and pods.	Healthy crops can tolerate and compensate for up to 30% leaf loss up to mid-flowering and no more than 15% leaf loss during the pod-filling period.
Loopers	Feed only on foliage.	Thresholds are the same as for foliage feeding *Helicoverpa*.
Soybean moth larvae	Blister, roll and web the leaves – plague numbers can build-up in dry years.	During flowering and podding do not allow plants to lose more than 15% of their total leaf area. Spray before the leaves become folded.
Pod feeders		
Helicoverpa spp. (heliothis)	A closed canopied crop is less favoured by egg laying *Helicoverpa* moths. Eggs laid at the top of plants suffer higher levels of mortality.	About two pod feeding caterpillars per square metre during pod filling stage.
Pod-sucking bugs and other sap-suckers		
Green vegetable bug (GVB), brown bean bugs, red-banded shield bug, brown stink bug	Significant yield loss is confined to the first two weeks of early pod fill. No yield loss occurs beyond mid pod fill. Seed quality is affected up until pods are too hard to penetrate.	For crushing or non edible beans approximately one green vegetable bug (GVB) or GVB equivalents per square metre. For human consumption beans – do not exceed 0.5 GVB per square metre.
Silverleaf whitefly B-biotype (SLW)	Nymphs are found on the underside of leaves. They suck sap and can deposit honeydew on foliage, upon which develops a sooty mould. Adults also suck sap and deposit honeydew.	There are no pesticides registered for silverleaf whitefly in soybeans. Conserve beneficial insects during the crop's vegetative stage and use 'soft' insecticides during the reproductive stage
Spider mites	Piercing and sap-sucking pests. Check under surface of leaf. Can become troublesome in dry weather or after use of broad-spectrum insecticide sprays.	During the reproductive phase treatment may be warranted if there is an average of five mites per square centimetre of leaf under-surface provided natural enemies are not active.
Stem-borers		
Lucerne crown-borer	Larvae bore down through the pith of the main stem. Near the base of the stem they girdle the inside of the stem when forming a pupal chamber thus weakening it and making the stem susceptible to lodging and the plant maturing early.	No action threshold has been determined. Control is by deep burial of crop residue; by crop rotation and eradication of Sesbania pea, Budda pea and Rattlepod weeds. Monitor the presence of adult beetles.

with low disruption effects to beneficial insects is strongly recommended.

More detailed information on insect pests and their control is available in the second edition of *Soybeans* (Agfact P5.2.6) and the Qld DPI&F publication *What soybean insect is that?*

Chemical control of insect pests

The guide *Insect and mite control in field crops* is produced by the NSW Department of Primary Industries and contains a summary of the common insect pests affecting soybean crops and lists the registered chemical options for their control. This publication is available from NSW DPI District Agronomists or can

Table 9. Some of the common beneficial insects and pathogens of pest species found in coastal soybean crops

PREDATORS	ROLE
Ants including meat ants	Attack many caterpillars and bug nymphs
Apple dimpling bug	Feed on plant tissue (most likely not a problem in soybean) but also on the eggs and young larvae of several pest species.
Big-eyed bug	Feed on silverleaf whitefly nymphs and eggs of several pest species.
Brown lacewing and nymphs	Feed on aphids and mites. Larvae (nymphs) feed on silverleaf whitefly nymphs.
Common brown earwigs	A predator of larvae and pupae of *Helicoverpa* and other lepidopterous pests, and also wireworm larvae.
Damsel bug	Nymphs and larvae are predators of eggs and larvae of *Helicoverpa* and other lepidopterous pests.
Dragonflies	Are generalist predators and feed on any pest or beneficial insect that they can capture.
Hover flies	Larvae (maggots) feed on aphids.
Ladybird beetles including the transverse ladybird beetle, common spotted ladybird beetle, minute two spotted ladybird beetle. Pollen beetles	Actively search and devour eggs and small larvae of most caterpillar pests, silverleaf whitefly nymphs, aphids and mites (see Figure 7).
Mantids	Eat whatever they can catch including adult moths.
Predacious wasps	Kill caterpillars.
Predatory bugs including the spined predatory bug and the glossy shield bug. Assassin bugs	Attack and consume the largest larva of *Helicoverpa* and other pest larvae, e.g. loopers and cluster caterpillars (see Figure 7).
Red and blue beetle	Eat eggs and small larvae of *Helicoverpa*.
Soldier beetle larvae	Feed on many soft-bodied insects.
Spiders	Predators that feed on a wide range of pests and beneficial species.
PARASITES	**ROLE**
Braconid wasps including *Microplitis* spp., and Ichneumonid wasps including the orange caterpillar parasite.	Lay their eggs in caterpillars which are then parasitised by the larvae of the wasp.
Encyrtid wasp	This tiny parasite lays its egg in the eggs of caterpillars. The wasp egg divides and many larvae parasitise the host larva.
Green vegetable bug egg parasite (*Trissolcus* sp.).	This tiny wasp moves systematically over the GVB egg raft to parasitise most of the eggs.
Encarsia wasp *Eretmocerus* wasp	Lay eggs in the nymphs of silverleaf whitefly. The parasitised nymphs of silverleaf whitefly then die and release a young wasp.
Tachinid flies including *Trichopoda*	Larvae are internal parasites of caterpillars and other insects. The *Trichopoda* fly lays its eggs on GVB. When they hatch, the larvae burrow into the bug and feed on its internal organs and body fluids.
Trichogramma wasp	Tiny wasp less than 0.5 mm that is difficult to see with the naked eye. Lays its eggs in those of *Helicoverpa* and loopers. The wasp larva develops into an adult wasp inside the egg and in so doing destroys the developing *Helicoverpa* or looper caterpillar.
PATHOGENS OF INSECTS	**ROLE**
Bacillus thuringiensis bacterium (Bt)	Infects *Helicoverpa* and looper larvae when they feed on it causing death due to the toxins produced by this bacterium. Bt is the active in 'Dipel SC'.
Beauvaria fungus	Usually infects weakened insects.
Entomophthora fungus	Has been observed infecting loopers.
Nomuraea fungus	Infects and kills larvae of loopers and *Helicoverpa*.
Nuclear polyhedrosis virus (NPV)	Infects larvae of *Helicoverpa* larvae causing death. More virus particles are then released into the crop as the dead caterpillars decompose. NPV is the active in 'ViVUS' and 'Gemstar' products.

Figure 7. Two examples of the soybean crop's many beneficial insects: Spined predatory bug (left) and Ladybird beetle (right)

be found on the NSW Department of Primary Industries website www.dpi.nsw.gov.au.

Information on registered chemicals for insect pests in soybean is available through the Australian Pesticides and Veterinary Medicines Authority (APVMA). Their website, www.apvma.gov.au contains a searchable database of currently registered and permitted chemicals for crop pests.

The Queensland Department of Primary Industries & Fisheries produces the InfoPest AGVET CD-ROM, which also contains searchable information on crop pests, registered chemicals, labels and links to Material Safety Data Sheets. It is available through the Qld DPI&F phone (07) 3239 3967.

Non-chemical methods for insect pest management

The range of commercially available non-chemical methods for insect pest management is increasing in Australia. Whilst producers of organic crops are already familiar with many of these options, they are becoming increasingly sought after in 'conventional' soybean production. Many of the developments in insect pest control aim to target the pest species whilst minimising the non-target impacts of the treatment, in particular to beneficial insect species in the crop. Some of these beneficial insects are listed in Table 9.

All soybean growers should adopt bio-intensive integrated pest management (IPM) programs. IPM practices include monitoring pest and 'beneficial' levels and the management (including release) of hyperparasites, predators and biological agents of insect and mite pests. Targeted specific pesticides and bio-pesticides are used when pest levels look like exceeding 'action thresholds'. Sequential flowering of trap crops and the release and management of trichogamma wasp and other agents can mitigate helicoverpa populations. Knowledge of the autocology and life cycles of pest species is essential in developing IPM strategies.

Some important bio-pesticides are *Bacillus thuringiensis* subsp. *kurstaki* (Bt k) products for Lepidopterous larvae control, and nuclear polyhedrosis virus (NPV) of *Helicoverpa zea* for controlling helicoverpa species. No products are registered or openly permitted for green vegetable bug control in organic soybean growing. Some control of green vegetable bug may be fortuitously gained by three introduced parasitic Tachinid flies of the genus *Trichopoda*.

Integrated pest management (IPM)

IPM is a term used to describe the modern approach to insect control whereby many strategies are integrated to minimise pesticide use and to reduce deleterious effects on the environment, whilst maintaining profitability (yield and quality). It aims to maximise the controlling influence of beneficial insects and to utilise pest-specific agents, such as viruses and fungal sprays, to control the pest species.

IPM does not preclude the use of chemical methods of pest management, rather it encourages the decision to use chemical sprays to be taken in consideration of other impacts.

It is not wise to consider the control of one crop pest in isolation, as this can easily lead to increasing the population of another pest through a reduction in beneficial insects that may be keeping other pests in check. The concept of IPM is extremely important when dealing with pests such as silverleaf whitefly.

Silverleaf whitefly

Silverleaf whitefly (SLW) is a small sap-sucking insect that feeds on the underside of leaves of a wide range of ornamental, crop and weed plants. Since its introduction to Australia, this strain of whitefly (*Bemisia tabaci* B-biotype) has spread into many cropping regions. It presents particular problems for control since it is resistant to many common pesticides and can develop resistance to new synthetic chemicals very quickly due in part to its rapid breeding cycle. Population explosions (billions of individuals per hectare of crop) have been experienced where inappropriate insect management has been followed, for example, where 'hard' pesticide sprays have been used to control other pests subsequently causing SLW populations to flare.

Fortunately there are many naturally occurring insects that predate and parasitise the nymphal stages of SLW. Maximising the populations of these beneficial insects in a crop is an important long-term strategy in preventing flares of silverleaf whitefly as well as other pests such as mites and aphids.

To assist soybean growers to understand and manage this pest, the publication *Silverleaf whitefly alert for soybean growers* was produced in March 2003. It is available through NSW DPI District Agronomists or from the NSW DPI website: www.dpi.nsw.gov.au.

DISEASES

Over 100 diseases of soybean have been recorded world-wide. Some of the more common and important diseases of soybean on the North Coast of NSW are described here.

Black leaf blight is caused by a fungus (*Arkoola nigra*). To date this fungus has only caused major outbreaks of disease in crops in the Hastings district, although it is present throughout the North Coast of NSW. The most striking symptom is the blighting of the leaves. Large irregular grey to brown spots with a yellow margin develop on the leaves. The centre of these spots may fall out giving a shot-hole and tattered appearance. Infection occurs in the early part of the growing season from ascospores released from fruiting bodies on diseased trash. Disease development and spread is favoured by warm wet weather and poor ventilation in crops. The disease spreads upward within the crop, blighting the top leaves and pods during the pod-filling stage. Control is by using seed from disease free crops; rotation with non-host crops; burning or burying trash; growing well ventilated soybean crops and minimising spread of infected material on boots, clothing and machinery. Iprodione products are registered for the control of black leaf blight.

Pod and stem blight is a disease caused by a complex of fungi (*Diaporthe-Phomopsis* spp. complex), which can be seed-borne or carried on crop residue. The disease becomes noticeable late in the season, causing premature yellowing of the top of the plant and early maturation of pods. After leaf fall masses of small black dots (spore producing bodies known as pycnidia) appear on stems, petioles and pods. On stems and petioles pycnidia are arranged in rows – on pods they tend to be scattered. The fungus is present in maturing seeds and can lead to a rapid deterioration of seed quality when harvest is delayed by wet weather. The disease is most prevalent in low-lying crops that have been subject to flooding.

Phytophthora root and stem rot is caused by a water mould (*Phytophthora sojae*) that can attack plants at all stages of growth. Disease development is favoured by poorly drained soils and wet weather. Control is achieved through growing tolerant varieties in well drained fields, practising crop rotation and preventing the introduction of the disease to disease-free areas via spores in drainage water or in infested soil attached to machinery. Once introduced, Phytophthora can survive in fields not growing soybeans for many years.

Seventeen races of *Phytophthora sojae* have been recorded in commercial soybean crops in Australia to date. Race 1 is the most commonly found strain on the North Coast of NSW. Race 15 has also been identified in this region but is not as common. In the irrigated soybean production regions of southern NSW and northern Victoria, this disease has become a major problem with seven new races being found since 2000.

A native Phytophthora species (*Phytophthora macrochlamydospora*) has also been recorded on the North Coast of NSW. It infects native legumes but generally has low virulence to soybeans.

Purple seed stain is caused by a fungus (*Cercospora kikuchii*). The disease causes a characteristic pink to dark purple discoloration of the seed and sometimes cracking of the seed coat. Seeds, pods, stems and leaves can also be infected (cercospora blight and leaf spot). Leaf infections are characterised by small dark red to purple spots, which can develop into angular or irregular reddish purple lesions first on the upper then lower leaf surface. Leaf symptoms are usually first observed at the seed setting stage. Affected leaves usually occur at the top of the plant with healthy, green leaves below. Extended periods of humidity and temperatures of 28–30°C favour disease development.

The fungus can be seed-borne and can over-winter on infected plant matter, infecting soybean plants at flowering. Control is primarily by using high quality planting seed and rotating with non-leguminous crops if disease levels become too severe.

Pythium is a water mould that infects roots of seedlings under wet soil conditions causing damping-off. This pathogen is ubiquitous and control is by sowing into well drained soil and providing conditions that favour rapid emergence. Cool seedbed temperatures (below 18°C); wet soils and sowing too deep places establishment at risk due to infection by *Pythium*.

Rhizoctonia seedling blight is caused by a soil-inhabiting fungus (*Rhizoctonia* spp.). Symptoms of infection by this fungus are sunken, brick-red areas on the lower stem and roots. Some plants may die; others remain stunted but may recover after producing roots above the diseased area. The disease is most serious in soil containing large amounts of undecomposed plant residue and where germination and establishment proceeds at a slow rate.

Rust is caused by a fungus (*Phakopsora pachyrhizi*) that is virulent on native legumes that grow throughout the North Coast of NSW. Build-up and spread of this pathogen usually occurs in March and is favoured by humid conditions with warm temperatures (22–28°C). Grey-brown pustules on the lower leaf surfaces release masses of minute rusty brown coloured spores, which can be spread by air and then germinate on leaves. The disease is worst in the near coastal cane-lands where heavy infection can cause premature leaf fall and a slight reduction in grain size. On the positive side, rust infections late in the crop can assist in leaf drop, hastening harvest and reducing the risk of damage to grain from wet weather.

Rust is not considered an important economic disease on the North Coast of NSW. There are rust resistant breeding lines; however, no current varieties grown are completely resistant to rust.

Sclerotium rot is caused by a fungus (*Sclerotium rolfsii*) that causes damping-off of seedlings. The white fungal threads spread from decomposing crop residue to infect germinating soybean seedlings. Infection is most serious under marginal seed-bed moisture conditions when germination and emergence is slow.

Stem canker is caused by a fungus (*Rhizoctonia* sp.). Sunken brick-red lesions extend up the stem. Stem canker is most evident during pod filling.

White mould is caused by a fungus (*Sclerotinia sclerotiorum*). Infection occurs at flowering and is favoured by extended plant surface wetness, moist soil and moderate temperatures (12–24°C). Later flowering crops are more subject to infection. The disease is first noticed when individual plants die. These plants are characteristically bright yellow and stand out clearly. Closer examination will reveal white cottony growth on the stems which enclose black fruiting bodies called sclerotia. Sclerotinia is unlikely to cause severe damage in the first year it is noticed, however, it can build up and cause significant losses in subsequent years. Control is by crop rotation, the use of disease free seed, the selection of varieties with tolerance to white mould, planting by direct drilling, establishing well ventilated crops, and avoiding lodging. The varieties Zeus and Manta have useful tolerance to white mould.

Other diseases that have been recorded in soybean crops in Australia but are thought to have little economic impact include: bacterial blight (*Pseudomonas syringae* pv. *glycinea*); bacterial pustule (*Xanthomonas campestris* pv. *glycines*); soybean mosaic virus; leaf spot (*Phoma* spp.); flower blight (*Botrytis cinerea*); Anthracnose (*Colletotrichum*), and downy mildew (*Peronospora manshurica*). There are varieties tolerant to downy mildew.

A new TopCrop publication from GRDC and Qld DPI&F called *Mungbean & soybean disorders: the ute guide* gives useful information on a wide range of diseases and environmental and nutritional disorders. It is available from GRDC Ground Cover Direct by phoning 1800 11 00 44.

HARVESTING

Good crop management pays off at harvest

Efforts in preparing an even paddock and eliminating obstructions such as stumps, large sticks and rocks will be repaid at harvest time, when ease of access of the header to the ripe pods is critical.

Sowing the correct variety at the optimum time for the region will also maximise harvest yield as the variety will set pods well above the ground and ripen in a timely manner.

Figure 8. A well-managed crop is easier to harvest.

Uniform, high plant populations assist in minimising harvest losses as the crop produces an even closed canopy. This in turn minimises weed development, assists the crop to stand up without lodging (Figure 8) and to feed into the harvester more efficiently.

All these factors enable the cutter bar on the header to be set low enough to access as many pods as possible without picking up soil or other contaminants, which degrade the quality of the grain particularly where it is targeted at culinary or export markets.

Correct grain moisture

The optimum moisture level for storage of soybean grain is 13%. Because of the high risk of autumn rain on the North Coast of NSW, which weathers and degrades ripe seed, crops are usually harvested at 15%–18% moisture content and then forced air dried within 24 hours of harvest.

When ripe pods are left too long in the field and moisture content falls below 12% substantial losses can occur with increased shattering of the pod and seed splitting at harvest.

Grain receival standards applying to soybean can be obtained through the National Agricultural Commodities Marketing Association (NACMA; see website listed below).

Correct header settings

Incorrect header settings result in grain losses. To minimise unnecessary losses of grain during harvest ensure that:

- the cutting height is low enough to gather low set pods into the header and to minimise the impact of the cutter bar higher up the plant, which increases pod shattering and grain loss;
- the correct header front is chosen for the crop height and topography. For example, a wide-front header may not be the best option if the crop is on very uneven or sloping land. A floating cutter bar, 'flexi-front' header or narrow front may be needed to overcome variability in crop height, low pods or sloping ground;
- if using an open-front header with a pick-up reel, the correct positioning and reel speed is obtained. A pick-up reel is preferable to a 'bat' reel;
- the position of the reel is 30 cm forward of the cutter bar;
- the speed is set at 1.25 to 1.5 times the ground speed to achieve an even and continuous feed into the header.

Consult the header manual or an experienced operator for further information.

MARKETING

Developing a grain marketing strategy

Australia is only a small producer of soybeans by global standards with production of around 70 000–110 000 tonnes. Production has declined in recent years largely due to the impacts of drought. Globally, in excess of 217 million tonnes of soybeans are produced annually. The US (85 million tonnes 2004–05), Brazil (53 million tonnes in 2004–05) and Argentina (40 million tonnes in 2004–05) are key players in the production and export of soybeans and soybean products.

Australia is a net importer of soy based products, with this primarily driven by demand for meal. This is unlikely to change significantly in the short to medium term.

Soybeans offer a number of marketing opportunities, but these will fall into two broad market end uses, namely crushing for oil and meal, and beans for human consumption (soyfoods). Growers should identify the market they wish to grow for and base this decision on sound principles, appreciating the characteristics of the North Coast environment.

A sound marketing strategy should start with knowing how much it costs to grow the crop. This will help to establish a target price at which to start selling. Be aware of historical highs and lows in the market when setting targets.

Identify key market information to follow such as domestic prices and commentary, the Chicago soybean, (and oil/meal) futures price and domestic crop estimates. Most major buyers now provide fax and email services covering this information. Independent sources are newsletters and the ABARE Crop Report.

Growers should understand contracts, including the legal obligations and what is expected of both the buyer and the seller.

Crushing market

Soybeans are crushed to produce oil and meal. Soybeans are referred to as a 'low oil' seed as they are approximately 80% meal and 20% oil. In contrast, high oil seeds like canola and sunflowers are 60% meal and 40% oil.

The demand for soybeans is a derived demand i.e. it is derived from the demand for oil and meal. There is some use of whole beans to produce full fat meal.

Australia is a net importer of soybean products and thus, local soybean prices are based on import parity. Soybean meal is regularly imported from South and North America.

Whole soybeans for crushing are generally imported from North America. The volume of imports varies considerably from year to year depending on local production, price relativities of seed, oil and meal and the requirements of domestic crushers. Due to quarantine restrictions imported soybeans must be crushed at port locations.

Meal

Australian produced soy meal competes with imported meal (48% min. protein) from North and South America. The Australian intensive livestock industry has been growing rapidly and was estimated to consume in excess of 800 000 tonnes of protein meals in 2004–05. The sector uses a wide variety of protein meals from both local and imported sources. In recent years, imported meals have accounted for more than 50% of usage, with imported soy meal accounting for around 30%–40% of meal consumed.

Australian soy meal competes with imported meal with adjustment for quality differences i.e. imported soy meal generally trades at 48% protein and local meal at 44% or 46% depending on the processing method.

As soybeans are approximately 80% meal, meal tends to drive the crushing demand. However, oil is the higher value commodity and an important contribution to the overall crush margin.

Oil

There is only a relatively small intrinsic demand for soy oil and it is generally used in blended applications. In recent years, much of the soy oil used in blended vegetable oils has been substituted by canola oil in Australia.

Australia does import soy oil, primarily from South America for both food and industrial purposes.

Currency

As Australia is an importer of all three products (oil, meal and beans) in the soy complex, the value of the Australian dollar plays a significant part in the value of Australian soybeans and products. The stronger the value of our currency against the US currency the cheaper imports become and consequently push the value of the Australian soybeans lower. The reverse will support and raise the value of imports and consequently the value of Australian soybeans.

Human consumption market

The edible soybean market has been expanding and there is increasing demand in both export and domestic markets. Premiums are paid over beans grown for crushing. Organically produced grain also attracts a premium. Varieties with a clear or light coloured hilum such as Cowrie, Surf, Warrigal, Soya 791, Dragon and A6785 currently supply the human consumption markets. Growers should contact end-users and buyers when making variety choices.

Soybeans are used in the manufacture of a wide range of products which include soy flour, soy milk, soy grits, tofu, tempeh, spreads, soup, confectionery and other Asian foods.

Human consumption markets generally prefer beans with good seed size (20–24 g/100 seeds), high protein and high germination percentages. Beans should be free from stains, soil, moulds and damage to the seed coat. There is very low tolerance for admixture and dark hilum seeds. Seed grading is normally required.

Genetically modified (GM) soybeans are not grown in Australia. Grower organisations such as the Northern Australian Soybean Industry Association (NASIA) in southern Queensland have developed a Declaration Form in response to Japanese buyers seeking 'identity preservation' records from time of planting to shipment. Through this process Japanese buyers will gain greater confidence in the quality of Australian beans.

AOF publishes delivery standards for crushing and edible soybeans. A copy of the standards is generally available from marketers or from producer organisations. AOF makes their standards available to NACMA who publish standards for all crops. NACMA have a producer package available for purchase which provides access to standards, contracts and dispute resolution.

SEED TESTING LABORATORIES

Casco Agrictech Ltd
214 MacDougall Street
PO Box 549
Toowoomba Qld 4350
Phone (07) 4633 0599 Fax (07) 4633 0711

E M Pascoe Seed Testing Services
12 Ridge St
Greensborough Vic 3088
Phone/Fax (03) 9434 5072

Seed Services Australia
Dept of Primary Industries and Resources SA
GPO Box 1671
Adelaide SA 5001
Phone (08) 8303 9549 Fax (08) 8303 9508

Seed Analysis
80 Herbert St
PO Box 13
Allora Qld 4362
Phone (07) 4666 2299 Fax (07) 4666 2199

Futari Grain Technology Services
15 Francis Street
PO Box 95
Narrabri NSW 2390
Phone (02) 6792 4588 Fax (02) 6792 4221

GrainCorp Growing Solutions
30 Barwon Street
Narrabri NSW 2390
Phone (02) 6792 1433 Fax (02) 6792 3825

Seed Testing Laboratory of Australia Pty Ltd
PO Box 2031
Mansfield Delivery Centre Qld 4122
Phone (07) 3849 2744 Fax (07) 3849 2704

SUGGESTED READING

Insect and mite control in field crops. NSW Department of Primary Industries

What soybean insect is that? (2004). Qld Department of Primary Industries & Fisheries

Mungbean & soybean disorders: the ute guide (2003). Qld Department of Primary Industries & Fisheries and GRDC

Silverleaf whitefly alert for soybean growers (2003). NSW Department of Primary Industries

Soybeans (1995) Agfact P5.2.6, second edition. NSW Department of Primary Industries

SoyCheck guidelines are available from your local NSW DPI District Agronomist

Crop insects: the ute guide (Northern Grain Belt edition). Qld Department of Primary Industries and Fisheries

Weed control in summer crops. NSW Department of Primary Industries

Crop weeds of northern Australia: identification at seedling and mature stages. (1995) Qld Department of Primary Industries & Fisheries

Weeds: the ute guide (Northern Grain Belt edition). Qld Department of Primary Industries and Fisheries

USEFUL WEBSITES

Australian Oilseeds Federation
www.australianoilseeds.com

Grains Research and Development Corporation
www.grdc.com.au

GrainCorp
www.graincorp.com.au

National Agricultural Commodities Marketing Association Inc.
www.nacma.com.au

National Oilseed Processors Association
www.nopa.org

NSW Dept of Primary Industries
www.dpi.nsw.gov.au

Pulse Australia
www.pulseaus.com.au

Qld Dept of Primary Industries & Fisheries
www.dpi.qld.gov.au

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DISCLAIMER

The information contained in this publication is based on knowledge and understanding at the time of writing (December 2006). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of New South Wales Department of Primary Industries or the user's independent adviser.

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