

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

AZUKI BEANS: IRRIGATED PLANTING GUIDE 2004-2005

Crop Management

Producing high yielding crops of premium quality azuki beans (*Vigna angularis*) for the Japanese and other Asian markets involves paying careful attention to many important aspects of crop management. The publication *A guide to growing azuki beans* deals with many of these aspects in considerable detail. Copies of the guide are available from the Forbes office of NSW Department of Primary Industries.

The development of improved agronomic practices since that publication in 1997 has resulted in additional crop management recommendations, which help to meet the continuing requirements of markets for premium quality beans.

This publication updates agronomic management recommendations and contains seasonal reminders for some of the more critical aspects of management which are often overlooked.

PREMIUM QUALITY AZUKI BEANS

Premium quality azuki beans are large, pale red beans, which are free from contaminants, staining and insect damage. A moisture content of 12–13% is desirable to prevent hard seed problems and to minimise processing time. Japanese markets have strict criteria for assessing azuki quality based on objective and subjective measurements.

Mild temperatures during flowering and late pod fill are required to produce large, pale azuki beans. The northern Japanese Island of Hokkaido with its short, mild summers produces the premium quality azuki beans against which Australian imports are judged.

Large, pale beans are preferred by Japanese customers to produce a premium quality paste. The Japanese market usually pays substantial premium prices of \$400–500/t for large, pale beans over small, dark azuki beans. The premium paid for better quality azuki beans varies depending on the Japanese import quota and the level of demand. Large, pale beans (premium quality) are considered more marketable in times of oversupply.

Our understanding of azuki bean quality has increased substantially due to recent developments largely driven by research results from Tony Hamilton's postgraduate studies at the University of Sydney, Azuki Check Program results, and closer relationships with Japanese customers. This understanding has

made quality management a practical and important aspect of azuki bean production.

INDUSTRY DEVELOPMENT

The following management recommendations have been developed largely through the Azuki Check program. This program involves simple monitoring against key management checks and discussion among growers and agronomists regarding crop performance and refinement of crop management. Growers are encouraged to participate in Azuki Check, as it allows objective comparison of crop management strategies.

The NSW Dry Bean Growers Association (NSW DBGA) is a farmer-driven incorporated body, established in 2000 to support the azuki industry and other specialty summer pulses. Azuki beans are not a leviable crop so no levies are collected by GRDC. The NSW DBGA collects voluntary levies from azuki bean growers, which are used to fund azuki research and development.

LOCATION

The river valleys of the southern and central slopes of NSW are considered the best environments for growing premium quality irrigated azuki beans (i.e. east of both Forbes and Griffith). Areas further west have warmer conditions during crop maturity, making quality targets difficult to achieve. At the other end of the scale, cold tableland environments can retard crop development and frosts represent a major risk. Minimum temperatures in the range of 10–14°C are suggested as ideal ripening conditions to promote large, pale azuki beans. Consistent minimum temperatures below 10°C can slow plant development and have detrimental effects on yield and quality.

CHOOSING THE RIGHT PADDOCK

Azuki grow best on alluvial river soils and sandy loams, similar to the soils preferred for irrigated lucerne production. Azuki do not tolerate waterlogged conditions, especially in the seedling stage. Azuki performance in heavy clay soils, even on raised beds, has generally been disappointing and these soil types are best avoided.

Good surface soil structure is essential to aid seedling emergence during the hottest part of the year. Gypsum may be required on soils prone to crusting.

Paddocks should be soil tested to determine soil fertility. Soils with pH less than 5.5 (CaCl₂) should be avoided or the soil limed.

Azuki can be rotated with a wide range of summer and winter crops, as long as paddock preparation and sowing time are not compromised. Azuki can be grown in consecutive seasons with good results. However, growers are encouraged to limit consecutive azuki crops to reduce build-up of problem weeds and diseases such as sclerotinia.

Previous bean crops can cause contamination problems. Paddocks with a history of crops such as mungbeans, cowpeas and natto soybeans within the last two years are likely to cause problems and may need to be manually rogued prior to harvest. Any paddocks that have the potential to cause contamination by these beans are best avoided.

Be very careful to follow guidelines on plant-back periods with residual herbicides. Problems have arisen in the past by growers not observing plant-back periods for herbicides such as the sulfonylureas (e.g. Glean[®], Logran[®] and Hussar[®]), Lontrel[®] (clopyralid), dicamba and Grazon[®] (triclopyr + picloram). Experience has shown that retaining cereal stubble increases the residual life of dicamba, so dicamba should not be used prior to sowing azuki.

PADDOCK PREPARATION

Azuki can be successfully double-cropped into cereal stubble. Under pivot irrigation systems cereal stubble is considered highly desirable as it can improve crop establishment by reducing raindrop splash or soil crusting and wind blasting of emerging seedlings. Azuki crops following fallowed lucerne have had significant soil infiltration problems under pivots, and in this situation it is suggested that a cereal crop be sown before azuki beans. Azuki has been double-cropped into canola, but this is not recommended due to problems with sclerotinia disease and herbicide residues (e.g. Lontrel[®]).

Heavy cereal stubble is likely to interfere with the azuki sowing operation. Baling is the most effective way of reducing heavy stubble loads, and still provides water infiltration benefits. Baling the stubble immediately after the cereal harvest is the best practice and will allow timely pre-irrigation. A stubble height of 10 cm after baling is considered ideal.

Stubble munchers or heavy harrows can help to break up light stubble, but are likely to be inadequate for heavy stubbles. In light cereal stubbles, set the header low, putting as much straw through the straw chopper as possible.

Stubble management will be different on border check and furrow irrigation systems. Sowing azuki into heavy cereal stubbles on flood irrigation systems can cause problems as stubble may impede field drainage and result in waterlogging. Azuki crop growth and yield are very sensitive to waterlogging.

Regardless of the irrigation system, paddocks need to have a level seedbed that assists crop establishment and ensures easy harvesting. Paddocks should be free from rocks and large clods. Cloddy soils should be rolled. Remember that the header front will be pushed along the ground when harvesting azuki beans, so make sure the paddock is level. Dust and dirt through the header will downgrade the sample.

SOWING DATE

Sowing date can dramatically influence azuki bean quality. Generally, early sown crops produce small, dark beans and late-sown crops produce better quality, large, pale beans (due to beans ripening in cooler conditions). Sowing date also has an impact on yield, with early sowing dates often having higher yield potential.

Suggested azuki sowing dates are therefore a compromise between achieving premium quality and not losing too much yield.

Sowing date is also dependent on location. The maturity of the azuki plant is dependent on temperature. This means that cooler areas will need to be sown earlier than warmer areas for the beans to mature at the same time. Azuki will mature in 100–140 days depending on location and season.

Suggested sowing dates are within 3 days of the following recommendations.

Suggested sowing dates	
Location	Suggested sowing date
Bathurst	3 December
Mudgee, Corowa, Wagga east	20 December
Eugowra and Wagga west	3 January
Narrandera and Leeton	7 January
Forbes and Griffith	10 January

VARIETIES AND SEED SUPPLIES

Erimo is the main variety grown in Hokkaido, North America and Australia, being preferred by Japanese customers for bean paste. Erimo is a Japanese-bred variety and is considered superior to Bloodwood, being higher yielding, slightly earlier in maturity and preferred by the market.

Two new Japanese varieties, Kita-no-otome and Shumari have been released in Japan in the last 10 years, offering improved disease resistance over Erimo, but no yield benefits. Japanese Plant Breeders Rights (PBR) restricts the growing of newly released Japanese plant varieties to within Japan for a period of 20 years from their release date. Growing the two new Japanese varieties in Australia could seriously jeopardise our azuki bean industry.

All azuki seed lines should be grown under a quality assurance scheme. This will help to ensure seed quality, varietal purity and freedom from contaminants. Contamination with mungbeans, soybeans and cowpeas has been a problem in the past, resulting in high grade-out losses and crop rejection. Crops to be kept for seed should only be desiccated with Reglone® as glyphosate can reduce the germination percentage.

INOCULATION

Azuki beans nodulate well with the new inoculum strain selected by Bob Gault of CSIRO. The most common technique for inoculating azuki beans is slurry coating. Ideally the seed should be inoculated on the morning of intended sowing. It is common practice to apply double the recommended amount of inoculant, as it is cheap insurance. Care needs to be taken when inoculating the seed so as not to cause seed damage. Many commercial seed cleaning facilities offer slurry inoculation services. Recently the Brushmaster® technique has been used successfully to inoculate large quantities of azuki beans. The water injection method is not common practice, but may be a practical method of inoculation if the machinery exists.

Inoculation failure can still occur. Make sure that freshly inoculated seed is kept cool prior to sowing. This can sometimes prove difficult in hot summer conditions. Do not apply any seed dressings or seed coatings as many of these can be toxic to the rhizobium. Azuki crops that have an inoculation failure will require nitrogen (N) fertiliser, unless the soil N fertility is very high. Generally azuki crops will require in excess of 100 kg N/ha fertiliser in the event of a nodulation failure.

FERTILISER

Azuki plants require good nutrition and display greater sensitivity to nutrient deficiencies than cereal crops. Phosphorus (P) and sulfur (S) are the two main nutrients likely to limit azuki growth.

Phosphorus (P)

Soils low in P will typically require >30 kg/ha of P. High P rates (>30 kg/ha) should be split (i.e. before sowing and at sowing) to avoid fertiliser burn and possible detrimental effects on *Rhizobium*. Good supplies of P are critical for early crop development and P fertiliser should always be applied around sowing.

Sulfur (S)

Soils low in S will need >20 kg/ha of S. Starter fertilisers are useful for applying large quantities of P, but usually contain little S. Gypsum is a good source of S and can improve soil structural problems.

Potassium (K)

K deficiency has been observed in some azuki crops

grown on alluvial sandy loams with a history of hay cutting. The deficiency can be easily overcome by applying muriate of potash before sowing.

Micronutrients

Molybdenum (Mo) should be applied once every three years to soils with low pH or suspected Mo deficiency. It can be applied as a seed dressing (Mo trioxide), fertiliser coat or with the trifluralin application (sodium molybdate). Some antagonism may be observed with certain glyphosate mixtures and sodium molybdate. Sodium molybdate can be toxic to rhizobium when applied to the seed and should not be applied in this manner.

Zinc (Zn) may be necessary on higher pH soils and areas cut during landforming. Do not apply foliar zinc fertilisers in a spray mixture with Spinnaker®, as it severely reduces the efficacy of Spinnaker®. Boron (B), Iron (Fe) and Calcium (Ca) deficiencies have also been suspected in some crops in the past.

The use of multi trace element foliar fertilisers during flowering has become popular in recent years. The decision to use these fertilisers is usually made in conjunction with tissue testing at the third trifoliate leaf stage. It is difficult to assess if these foliar fertilisers are beneficial or not, but given the short maturity of azuki beans, there is little time to allow trace element nutritional deficiencies to manifest, and a preventative strategy may well be the best strategy where deficiencies are suspected. Consider leaving untreated strips through paddocks when using foliar fertilisers to help diagnose deficiencies and tailor future trace element use.

Nitrogen

Research trials have shown no yield or quality advantages from N fertiliser application when the new improved inoculum strain is used and the crop has successfully nodulated. However, field experience in recent years has shown that first year azuki crops often appear less thrifty than subsequent crops. It is thought that carry-over of rhizobium in the soil following the first crop contributes to colonising the roots and helps to improve the nodulation of subsequent crops. This has raised questions as to the possibility of responses to post-emergent N applications in first year azuki crops and also crops with poor nodulation.

The soybean nodule scoring chart can be used to assess azuki nodulation success. It is not known exactly what nodulation score can be considered adequate for azuki. The best estimate is that a nodulation score of less than 3 at 40 days post-sowing is less than ideal and warrants further investigation. In this case it is suggested that growers consider applying N test strips at rates of 40–50 kg N/ha to assess the potential responses to N applications. If these strips show obvious improved crop growth and nodulation remains poor at 50–60 days post sowing, apply 40–50 kg N/ha to the paddock. Leave out test strips as a

comparison. Liquid fertilisers will usually give quicker responses than urea, but care needs to be exercised as some foliar fertilisers cause foliage burning.

Should a crop require N fertiliser, applications are best timed between early flowering and early pod fill, as this is the time of peak N demand. N fertiliser may promote excessive biomass production, which can increase sclerotinia disease pressure and increase maturity length. Applying large quantities of N fertiliser (50 kg N/ha) at sowing has caused germination problems on several occasions.

CROP ESTABLISHMENT

Azuki beans are best sown in narrow rows of less than 30 cm spacings. Trials have clearly shown that narrow rows produce taller plants (making harvest easier) with higher yield potential. Wide rows (i.e. 66–70 cm) are used extensively in Japan and North America, but these crops are usually harvested with bean knives (i.e. cut below the ground) to overcome problems associated with wide rows and lower pod height. However, wider rows allow inter-row cultivation and may reduce sclerotinia disease pressure. Wider rows may also help improve pesticide penetration through the canopy.

An even plant establishment is essential for high-yielding crops. Trials and Azuki Check data have shown that yield penalties for low plant densities are severe. Target plant populations are in the range 40–70 plants/m².

Situations that favour higher plant populations (i.e. 60–70 plants/m²) are:

- northern and western growing areas such as Forbes and Griffith with low sclerotinia pressure
- beds and border check irrigation layouts.

Situations that favour lower plant populations (i.e. 40–50 plants/m²) are:

- higher altitude and cooler/longer growing season areas such as Bathurst
- eastern areas such as Wagga with high sclerotinia pressure
- pivot or spray irrigation systems
- conditions that favour rank growth.

The recommended sowing dates are set to achieve quality targets but leave little room for re-sowing if poor emergence occurs. Azuki Check results show that yield losses are more often due to lower than optimal plant populations than higher than optimal populations. Consider re-sowing if density is <30 plants/m².

$$\begin{aligned} & \text{Sowing rate (kg/ha)} = \\ & \text{target density (seeds/m}^2\text{)} \times 10\,000 \\ & \text{divided by:} \\ & (\text{seeds/kg}) \times (\text{germination \%}) \times (100\% - \text{emergence loss\%}) \end{aligned}$$

Seed size typically ranges from 7000 to 9000 seeds/kg. Field experience has shown emergence losses can vary enormously from almost nil to well over 50%. Extreme temperatures at sowing and surface sealing caused by a rain shower are often the main causes of high seedling losses. Use an emergence loss figure of 5–15% when calculating sowing rates. Losses under pivot irrigators are likely to be less than under flood irrigation.

Seed lots should have germination >80%. Lines with <80% germination may have lower seedling vigour. Like most pulse crops, azuki contains a certain proportion of hard seeds. The proportion of hard seeds in a seed lot reduces with storage time. Germination tests immediately after harvest will not provide a good indication of seed germination potential. Germination tests should be conducted as close to sowing as practical. Abnormal seeds (primarily due to harvest and handling damage) must also be considered when determining sowing rates. Often these deformed seeds germinate giving deformed seedlings which will emerge and establish under good conditions, but may not always develop into viable plants. Seed testing should be done by an approved laboratory with experience in testing summer pulses.

Sow azuki beans into good moisture at a depth of 3–5 cm. Rolling and press wheels can help to conserve moisture and level the ground, but may increase the potential for surface sealing on border check irrigation systems if rain falls before emergence. Azuki should begin to emerge within 7 days of sowing.

CROP PROTECTION

There is a limited range of registered chemicals for crop protection in azuki beans. Growers are reminded that it is illegal to use unregistered products and that it contravenes quality assurance programs.

Tables 1 and 2 (at the end of this publication) detail pesticides that are registered or that have a permit for use in azuki beans for the 2004–05 season as at the date of this publication. Always read the label of all chemicals and permit details prior to using a pesticide. Always use pesticides in accordance with the label.

Weed control

Weed control programs should be planned with your agronomist before sowing. There is a limited range of registered herbicides for azuki, so control strategies of problem weeds require careful planning.

Azuki should be grown in rotation with other crops to reduce total weed pressure, resulting in less reliance on herbicide control. Poor weed control will result in reduced yields and grain contamination and staining.

The following issues are important to consider in a typical weed control program.

- Use of a pre-sowing herbicide provides early control of most problem grass weeds and some broadleaf

weeds. Trifluralin is the only product registered for pre-emergent use on azuki beans for both full soil incorporation and direct drill.

- Dual Gold® application post sowing/pre-emergence for milk thistle (*Sonchus* spp.) control. Milk thistle is often a problem in paddocks with a long history of azuki growing, or azuki crops that have low plant density. Milk thistle can especially be a problem at harvest time, delaying crop dry down and causing seed staining. Good, even establishment of the crop at the correct density helps to reduce milk thistle. Spinnaker® will not control milk thistle. Experience has shown that the higher rate of Dual Gold® will give superior milk thistle control. Double cropping azuki into heavy cereal stubble is likely to reduce Dual Gold® performance. Removal of stubble by baling is important in situations where Dual Gold® is needed to control large numbers of milk thistle.
- Post-emergent application of Select® grass herbicide is essential in direct drilled double cropped situations. Expect volunteer cereals to emerge quickly and be very competitive. Select® should be applied early in the crop's development, typically 10–20 days post-sowing. Delaying application until all grasses have germinated could result in significant yield loss from weed competition. In some cases late germinating weeds could mean that a second application may be needed. Apply during the cool of late afternoon to improve efficacy on weeds.
- Spinnaker® can be used pre-emergent or post-emergent to control a range of broadleaf and grass weeds. It is mostly used post-emergent, for control of Bathurst burr. Spinnaker® can cause some phytotoxicity on the crop depending on seasonal conditions but azuki generally recover from Spinnaker® damage within several weeks. Key points for the effective use of Spinnaker® include the following.
- Apply at 10–30 days post-emergence, when weeds are in the 2–4 leaf stage. Aim to apply one week after the application of a group A herbicide.
- A wetter or crop oil should be used with Spinnaker®. Crop oils increase chemical uptake by the plant. This can improve the efficacy of Spinnaker® on weeds, but can also result in crop phytotoxicity. A wetting agent is considered a safer option, but can result in poor control of some problem broadleaf weeds.
- Do not mix Zn foliar fertiliser products with Spinnaker®, as they can dramatically reduce the efficacy of the herbicide. Foliar Zn fertiliser is often applied after the Spinnaker® to help aid crop recovery from potential Spinnaker® damage. However, the effectiveness of this practice has not been proven.

- The exact conditions that favour Spinnaker® crop damage are not well understood. It is generally considered that conditions that favour azuki crop damage also favour good weed control. Applying Spinnaker® in very hot conditions may result in poor weed control.

Insect control

A wide range of chewing and sucking insects can be a problem in azuki, reducing yield and quality. These are described in the publications *A guide to growing azuki beans* and *Insect and mite control in field crops*. Insect control in azuki will require careful management and should be done in conjunction with a qualified and experienced agronomist.

Insects

Heliothis (*Helicoverpa* spp.) is often the main pest of azuki. Insecticide resistance can build up in the *H. armigera* population over its 3 summer generations. Therefore late maturing crops of azuki beans are predisposed to potentially highly resistant caterpillars. Intensive crop scouting and early control is essential. Insecticides should target the eggs or newly hatching caterpillars. Because azukis are late maturing and could be host to large populations of resistant *H. armigera*, growers should pupae bust (cultivate) azuki fields after harvest to help break the heliothis life cycle.

Growers should aim to follow the regional Insecticide Resistance Management Strategy where possible.

Mirids are another common pest, resulting in pod abortion and low yields. Research in Queensland has shown that often only 15% of the total mirid population is detected during crop scouting. Mirid thresholds are low and careful scouting will be needed to detect their presence. The publication *Controlling mirids in mungbeans* published by the QDPI&F provides detailed information which is also relevant to azuki.

Thrips and jassids are common problems in the seedling stage. They can be easily controlled with insecticide. However, research in Queensland has shown that their impact is often low and any early insecticide application can have a detrimental effect on beneficial insect numbers.

A range of other insects can also impact on azuki. Thresholds and critical control comments are provided in Table 3.

Crop scouting and insect thresholds

Azuki should be scouted weekly up to flowering, and at least twice weekly from flowering to late pod fill.

Insects thresholds are linked to a standard technique called beat cloth equivalents. A standard beat cloth is 1.3 m wide × 1.5 m long. The beat cloth is placed along the row and a 1 metre stick is used to shake insects onto the beat cloth. Insects can then be counted and

adjusted for the row spacing to convert to insects/m². Sweep nets are less accurate and should not be used, as many smaller heliothis are often missed. Egg counts can be a useful way of assessing heliothis hatchling potential.

Integrated Pest Management (IPM) programs

Beneficial insects have an important role to play in IPM strategies in azuki. Their main role is in the predation of heliothis, thus reducing heliothis pressure. The value of beneficial insects is difficult to quantify but beneficials should be taken into account at marginal pest thresholds (i.e. if good predator numbers are present, either hold off or only use a 'soft' insecticide). Key beneficial insects in azuki crops include soldier beetles, lacewings, lady beetles, red and blue beetles, predatory shield bug, damsel bug and big-eyed bug.

Generally insect control programs should aim to use the 'softer' (on predators) insecticides such as Bt and endosulfan through flowering and early pod fill. 'Harder' (on predators) insecticides such as carbamates are best used later in the development of the crop. Synthetic pyrethroids (SPs) are very hard on beneficial insects. Even small amounts of pyrethroids are harmful. High levels of resistance in heliothis (*H. armigera*) populations could result in poor control or a spray failure to pyrethroids, carbamates and even endosulfan. Ensure that spray rigs are cleaned of any 'hard' pesticides (e.g. SPs) before applying 'soft' pesticides.

The newly approved insecticides Steward[®] (APVMA PER7221) and Tracer[®] are very specific to *Lepidoptera* spp. (e.g. *Heliothis*) and soft on beneficials. However, only 1 application per season of Steward[®] is permitted, so users need to be strategic in its use.

Insecticide application

A well-grown azuki bean crop will produce a dense canopy, making it difficult to achieve satisfactory insecticide penetration. High water rates (200–400 L/ha) should be used where possible, especially when targeting high insect populations. Low volume aerial applications should only be used as a last resort. Water sensitive paper placed in the crop canopy can be useful for checking spray coverage. Insecticide effectiveness should be checked after application. Observe crop re-entry periods as specified on product labels.

Disease control

The fungal disease sclerotinia has been a serious problem in some azuki growing areas over the past few years. The disease is favoured by wet, humid conditions at mid to late flowering. The disease infects the dead flower petals on the end of small pods, and then spreads very quickly through the pods and then

to the rest of the canopy. Sclerotinia tends to be worse in crops with dense canopies and high yield potential. Yield penalties can be severe – more than 50% in some cases.

In low risk areas, crop rotations may help to minimise sclerotinia. Rotations should aim to limit consecutive azuki crops and azuki should not be sown after canola or other winter broadleaf crops. Experience suggests that these practices will not prevent sclerotinia, but may reduce its impact.

In areas with high sclerotinia pressure the fungicide Fortress[®] 500 (APVMA PER8091) allows in-crop management of the disease. Fortress[®] 500 is expensive and 2 applications may be needed to achieve satisfactory control. Sclerotinia management will require intense crop monitoring.

The following management guidelines have been developed using the experiences of farmers, agronomists and scientists.

Pre-sowing

Assess sclerotinia risk potential of the paddock. High risk factors include:

- districts with large areas of winter and summer broadleaf crops. Eastern districts such as Wagga and Cowra have a higher proportion of canola and lupin crops and as such have a greater sclerotinia spore loading than more western and northern districts such as Leeton and Forbes. Sclerotinia spores can travel long distances but isolated crops will be at less risk.
- paddocks with a history of broadleaf crops/weeds within the last 12 months. A break of 3–4 years between broadleaf crops in rotations is the most effective way of reducing sclerotinia spores within paddocks. However, the district spore load could be just as significant as the paddock spore load.
- paddocks with a history of sclerotinia infection.

A fungicide spray program may be needed if paddocks are a high risk. Those crops with a lower risk are best managed through careful monitoring around critical times and the ability to quickly apply fungicide on demand.

Sowing

- High-risk crops – consider sowing crops slightly earlier than the suggested dates. Wide rows (> 50 cm) may help to reduce sclerotinia pressure in high-risk crops through better aeration and improved spray coverage. However, wide rows may lower yield potential and should only be used in very high risk situations or in situations where fungicide control may not be possible. Consider aiming at target densities within the lower suggested range (i.e. 40–50 plants/m²).
- Low-risk crops – standard sowing techniques and target densities apply (i.e. 60–70 plants/m²).

Flowering (starting at about 40 days after sowing)

Assess for basal infection of sclerotinia. The extent and effect of basal infection in azuki is not known, but consider treating if more than 5% of plants are affected.

Mid-flower – early pod (about 55 days after sowing)

This is a critical time for sclerotinia infection because early flowers will start to senesce and spread the spores. Crops should be monitored 2–3 times weekly for sclerotinia during this time. Monitor carefully after infection periods (i.e. rainfall events and high humidity).

- High-risk crops – Treat with Fortress[®]500 at the first sign of sclerotinia infection. Monitor closely. Apply a second spray 7–10 days later if required. Some growers have applied a preventative spray (from 55 days after sowing) when conditions favour sclerotinia infection, but prior to the disease being visible. Conversely an early application of a preventative spray when disease pressure is very low might best be saved for later in crop development when sclerotinia pressure may be very high. Only two applications of Fortress[®]500 are permitted within a season.
- Low-risk crops – Treat with Fortress[®]500 if sclerotinia appears as the disease could reduce yield potential by more than 5%.

Late flower (>70 days after sowing)

- Continue monitoring, especially following infection periods (i.e. rainfall).
- Low risk areas – treat with fungicide if sclerotinia has the potential to reduce yield potential by more than 5%.
- Be aware of the withholding period on Fortress[®]500. Residue limits are strictly enforced in Japan.

Water rates

Coverage is critical for good control. Apply enough water to the point of run-off, usually around 400 L/ha. Use high water rates when disease pressure is high.

Grazing

Do not graze or cut crops for fodder that have been treated with Fortress[®]500 (see product label).

IRRIGATION

Azuki responds to good irrigation management. Moisture stress will cause flower abortion and produce more indeterminate growth, resulting in poor yield and seed quality. However, azuki are also very susceptible

to waterlogging, which results in poor plant growth and reduced nodule function.

Irrigation is needed to ensure good establishment. Once established, irrigation management needs to focus on preventing crop stress due to a lack of soil moisture or from waterlogging.

Soil moisture monitoring systems have proven their worth in irrigation scheduling. A variety of monitoring systems are being used, ranging from gypsum blocks to automatic systems. The critical zone for monitoring is 10–50 cm depth. Azuki crops will often show signs of stress when extracting moisture from below 50 cm. Aim to dry down the profile to refill point by the time of desiccation. Be careful with late irrigations on slow maturing crops that will be harvested after late May, as it could cause trafficking problems leading to harvest delays.

Water use budgets need to be conservative in case of very hot and dry seasons. If irrigation supplies won't cover the budget, reduce the crop area. For further information on irrigation scheduling techniques please contact a NSW DPI Irrigation Officer.

Particular issues that apply to the different irrigation systems are as follows.

Pivot/spray irrigation

Growers should budget on 5–7 ML/ha for pivot/spray irrigation systems in low altitude areas of the river valleys. Cooler high altitude tableland areas like Bathurst use substantially less water, about 3–5 ML/ha.

Pivot/spray irrigation systems need to have enough capacity to keep up with crop demand in very hot summer conditions. The recommended capacity is >12 mm of water/ha/day. If pivots have a capacity of less than 10 mm of water/ha/day, only sow a portion of the pivot to improve capacity over the crop area.

Water infiltration problems at the extremity of large pivots can be a problem. Reduced soil cultivation and stubble retention will help to improve infiltration rates. Pivot and sprinkler head design also needs to be matched to the soil type to ensure that application rates match potential infiltration rates. Uneven water distribution from sprinkler heads is a common problem on pivots. Catch cans are a very simple but reliable method of ensuring the correct nozzle outputs.

Irrigation before planting is essential under pivot/spray irrigation systems. Aim to have at least 60 cm of wet soil at sowing. It will help to buffer against hot weather and possible short delays in irrigation timing.

Experienced growers will often use cool weather early in the crop's growth stages (if it occurs) as a chance to add to the pre-irrigation level of subsoil moisture.

Flood irrigation (furrow and border check)

Flood irrigation layouts should have good drainage to reduce the period of waterlogging after each irrigation. Fields should be laser levelled with adequate tail drains to prevent water from backing up. Ideally flood irrigation systems should have the capacity and layout to apply and drain fields within 6 hours.

Border check fields with slopes in the range of 1:500 to 1:1000 are considered ideal. Pre-irrigate and sow into moisture on border check systems.

Furrow irrigated bed systems can be sown dry and watered up provided the beds sub well. Experience has shown that narrow row spacings with 5–6 rows/bed are ideal. Beds need to be flat on top to make for easy harvesting and furrows need to be deep to allow good drainage. Retained cereal stubble in double-cropped situations can increase the likelihood of waterlogging. Azuki are more sensitive to waterlogging than soybeans, making slope, run length and furrow depth critical in minimising the risk of damage from waterlogging.

Subsurface drip tape

A small area of azuki has been grown on subsurface drip tape. The ability to apply surface irrigation has been needed to help to ensure reliable establishment. Ideally the seed lines need to be directly over the drip tape. This can be achieved by using B line technology (satellite steering).

REMOTE SENSING

Remote sensing has become a popular management tool in recent times to improve azuki crop management and lift yields. An airborne camera (from aeroplane or satellite) takes infra-red images of a crop. Approximate cost is \$3–\$5/ha. The images highlight variation in crop growth within fields. Differences in plant establishment, crop nutrition, weeds and irrigation become more obvious and identifiable. This has had management implications in the following areas:

- Early identification of poorly performing areas of paddocks. These areas can then be assessed on the ground using techniques such as tissue testing to determine the possible cause. It is important that these areas be identified early and management action taken. The best time to assess growth using remote sensing is 30–40 days after sowing.
- Irrigation monitoring. Water coverage across the field is highlighted. This has proven particularly useful in checking correct nozzle distribution for pivots. It has also been used to check that scheduled irrigations are being correctly timed.
- Assessing large scale strip trials.

THE HARVESTING PROCESS

A good standing crop of azuki will have more than \$3000/ha worth of grain ready for harvest. Timely and efficient harvesting can make a large difference to crop profitability. For example, a 5% harvest loss can cost \$150/ha. Grain will darken with age, declining in quality the longer it remains in the paddock.

Desiccation

Azuki beans have not always been desiccated, largely due to earlier harvesting dates resulting from earlier sowing dates and the effect of high mite populations causing natural defoliation. However, later sowing dates, a higher emphasis on quality and the registration of Roundup® PowerMax has made desiccation standard practice.

Roundup® PowerMax is the preferred desiccant. Crop brown-out is slower than with Reglone®, but it results in better plant dry down and improved harvestability. Reglone® is the preferred option only in situations where quick defoliation is needed to avoid inclement weather or for use on seed crops. Do not use Roundup® PowerMax on crops intended for planting seed as it is not registered for this use and may reduce seed germination.

Roundup® PowerMax should be applied when 80% of pods have turned yellow–brown. Most azuki crops will be largely self-defoliated by this stage. Experience has shown Roundup® PowerMax to be beneficial even when a crop is nearly all self-defoliated, by making the crop mature more evenly and by drying green weeds. Crops should be ready for harvest around 15–20 days after application of Roundup® PowerMax.

Trials have shown that severe yield penalties can occur if the crop is desiccated too early. Timing of desiccation is easier to determine on crops maturing evenly. Uneven maturity is usually due to more indeterminate growth as a result of crop stress or uneven soil types.

Windrowing

Most azuki crops are direct headed without the need for windrowing.

Windrowing of desiccated azuki is sometimes used to help to pick up pods low in the crop canopy and to increase the speed of harvesting. Windrowing and harvest occur within the same day to reduce the risk of rain on the windrow.

Windrowing is not recommended as a method of aiding azuki crop dry down. The windrowed crop will take up to a week to dry down and rainfall during this time could completely ruin the crop. For such a high value crop this is considered too risky.

Windrowing crops on red soils has caused some problems in the past, as these soils often raise a lot of dust when the windrows are picked up, resulting in the sample looking very dusty. This is not such a problem on heavier/darker alluvial soils.

Windrowing should occur on desiccated crops in the early hours of the morning (with dew present) to prevent pod shattering. Windrowing dry crops in the afternoon heat is likely to lead to high shattering losses.

Where practical do not windrow more crop than can be picked up by a header the same day.

Harvesting

Harvesting should occur as soon as the crop is ready. Target a grain moisture content of 12–15%, but expect harvesting to be difficult. Azuki can be very ropy unless allowed to dry down sufficiently. Rotary headers are preferred over conventional headers.

Grain handling after harvest should be minimal, to minimise damage to the grain. Ideally grain should be augered only once, from the header to a waiting truck, and then delivered to the grading shed where it will be handled with tube conveyors. Experience has shown mother bins can be used to temporarily store grain if caution is exercised and the augurs are run full to avoid grain damage. Deliver high moisture grain immediately to the grading shed to prevent grain spoilage. Header and truck hygiene is paramount, and both should be part of a quality assurance program.

Report any weed or dirt contamination issues to the seed cleaner to ensure thorough cleaning and grading. Contaminants such as Bathurst burr and small clods can be difficult to remove in the seed cleaning process.

POST-HARVEST MANAGEMENT

Management of azuki bean stubble can be difficult in double crop situations with cereals. Azuki is often not harvested until May, which clashes with winter cereal sowing. Azuki stubble is very ropy and it can be physically difficult to sow into heavy azuki stubble.

Grazing restrictions apply to crops that have been treated with pesticides. Grazing withholding periods apply for Steward[®], Tracer[®], endosulfan and Fortress[®]500 (check the product label).

Burning azuki stubble in windrows is a practical way of reducing large clumps of stubble. However, this may prove difficult in May when temperatures are lower and rainfall is more likely.

Cultivation of azuki stubble immediately after harvest is the recommended practice. This will help to incorporate azuki stubble and if it is done to a depth of 10 cm will bust heliothis pupae. The offset disc method is preferred under pivot/spray systems, provided soil moisture conditions are not too wet, causing smearing. Care needs to be taken when using offset discs on border check layouts as this can alter field levels, resulting in uneven water application.

FURTHER INFORMATION

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Acknowledgments

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Table 1. Registered pesticides for use on azuki beans 2004/05

Pesticide	Chemical name	Trade name(s)	Registration details	Use comments	Withholding period	
					Grazing	Harvest
Herbicide	Trifluralin	various	Azuki beans	Conventional, full incorporation	<i>Not required</i> ^A	<i>Not required</i> ^A
	Glyphosate	Roundup® PowerMax	Azuki beans	Desiccation (not on seed crops)	1 week	1 week
	Diquat	Reglone®	Dry beans	Desiccation	1 day	4 days
Insecticide	Dimethoate	various	Azuki beans	Sucking insects	not stated	2 weeks
	Endosulfan	various	Azuki beans	Heliothis and sucking insects	4 weeks ^B	4 weeks
	Methomyl	Lannate® + various	Beans and legume seed crops	Heliothis and sucking insects	not stated	1 week
	Deltamethrin	Decis® + various	Pod and bean crops	Heliothis and sucking insects	not stated	1 week
	Spinosad	Tracer®	Grain legumes	Heliothis and loopers	2 weeks	2 weeks
	Bt	Dipel SC®	Azuki beans	Heliothis	<i>Not required</i> ^A	<i>Not required</i> ^A

Table 2. Pesticide permits held for use on azuki beans 2004/05

Pesticide	Chemical name	Trade name(s)	Permit details	Expiry date	Use comments	Withholding period	
						Grazing	Harvest
Herbicide	Trifluralin	TriflurX®	PER7187	30/6/09	Direct drill, incorporate by sowing	<i>Not required</i> ^A	<i>Not required</i> ^A
	S-Metolachlor	Dual Gold®	PER6627	26/11/08	Milk thistle and others	13 weeks	<i>Not required</i> ^A
	Clethodim	Select®	PER5243	30/6/05	Grasses	8 weeks	<i>Not required</i> ^A
	Imazethapyr	Spinnaker®	PER5598	30/9/07	Broad leafs and grasses	4 weeks	4 weeks
Fungicide	Procymidone	Fortress® 500	PER8091	31/12/06	Sclerotinia	Do not graze	21 days
Insecticide	Indoxacarb	Steward®	PER7221	1/3/06	Heliothis and mirids	4 weeks ^C	4 weeks

^A Not required when used according to the label

^B 6 week slaughter interval applies in addition to the 4 week WHP (consult the product label)

^C 4 week export slaughter interval applies in addition to the 4 week WHP (consult the product label)

Table 3. Insect thresholds and critical control comments

Pest	Threshold and critical control comments
Cutworms	<p>Potential establishment pest. Treat at first sign of seedling damage after confirming that cutworms are the cause of the problem, and not a seedling disease or plant disorder.</p> <p>Spasmodic in occurrence.</p>
Thrips	<p>The impact of thrips damage on seedlings and subsequent plant maturity and yield is not well understood.</p> <p>Lack of data on flower damage. Current DPI&F threshold in mungbeans is 4–6/flower.</p> <p>Suggest spray if 15/plant.</p>
Jassids (vegetable jassids)	<p>Count jassids on individual plants (count them very quickly). Threshold of 15/plant is based on a plant 30 cm high and a population of 45 plants/m² which equates to 675 jassids/m².</p> <p>Small stressed plants may be more susceptible to damage.</p>
Pod suckers - rated in terms of GVB equivalents.	<p>Threshold varies depending on number of seeds/m² (i.e. crop size) and the maximum allowable damage specified by the buyer.</p> <p>Action is required <i>before</i> the threshold is reached, so as to retain the quality premium and to avoid harvested crops being downgraded to stockfeed.</p>
Green Vegetable Bug (GVB) = 1 GVB	Scout crops thoroughly to maximise the chance of detecting bug nymphs.
Red Banded Shield Bug = 0.33 GVB	<ul style="list-style-type: none"> • For a poor yielding crop with only 500 seeds/m² (i.e. ~ 0.6t/ha) the threshold in theory could be lower than 0.1 bugs/m², if only 1% damage was allowed. In practice, it is unlikely that controlling bugs would be economic in such a crop.
Brown Shield bug = 0.2 GVB	<ul style="list-style-type: none"> • For a high yielding crop with 2000 seeds/m² (2.5 t/ha) the threshold would be in 0.7 – 0.8 bugs/m², if 2% damage was allowed.
Brown bean bugs = 1 GVB	Ascertain the amount of damage tolerated by the different markets (this most likely fluctuates from year to year depending on supply).
Etiella (lucerne seed web moth)	<p>No validated threshold yet. Threshold would need to be moth based, as larvae feed in pods, are not visible, and are impossible to reach with pesticides. Beware if lots of moth activity.</p> <p>Refer to QDPI&F publication <i>Etiella control in peanuts</i> for more information.</p> <p>Grade seed after harvest to remove as many damaged seeds as possible.</p>
Two spotted mite	<p>Spasmodic in occurrence.</p> <p>Problems associated with nearby maturing maize and broadleaf perimeter vegetation</p> <p>Avoid spraying synthetic c pyrethroids or carbamates on nearby maize crops early in the season.</p> <p>Avoid planting adjacent to earlier maturing hosts.</p>
Mirids	<p>Threshold depends on chemical choice.</p> <p>Dimethoate = 0.3 – 0.5/m² (lower threshold because Dimethoate is cheap).</p> <p>Consider raising this in interests of IPM, e.g. to 0.7/m², but crops must be scouted regularly (twice weekly) in case populations are increasing rapidly.</p> <p>Steward threshold = 1.0 – 1.3/m².</p> <p>Thresholds include total green and brown mirids and their nymphs.</p>
Grass blue butterfly	<p>No data for effect on azuki beans.</p> <p>Suggest use of soybean threshold. Before flowering 30% leaf loss, 25% growing points lost. Flowering onwards 15% leaf loss.</p>

Table 3. Insect thresholds and critical control comments

Heliothis	40% defoliation pre-flowering 1/ m ² post-flowering
	Problem mainly limited to coastal areas and Qld.
Loopers	40% defoliation pre-flowering. 3/m ² after flowering. Bt will control small to medium loopers.
Bean pod borer	Mainly a problem in Queensland crops and rarely occurs so far south. Be aware of this pest and report any outbreaks so that they can be verified.
Aphids	Consider control when large colonies form.

Azuki Check – crop management checklist**Pre-sowing checks**

Avoid unsuitable paddocks	Avoid clay soils. Azuki grow best in soil suited to lucerne. Be aware of herbicide residues and contamination from previous crops. Paddocks should be level.
Irrigation system	Spray irrigated systems need high capacity to cope with hot weather. Flood irrigated paddocks should be laser levelled with a capacity for water on and off within 6 hrs. Irrigation monitoring and scheduling is vital.
Stubble management	Cereal stubble will help infiltration on pivots, but may cause waterlogging on flood irrigation.
Obtain good quality seed	Check for contamination, seed size and germination.
Assess soil fertility	P and S are essential, and consider K, Zn, Mo and B.
Irrigate pre-sowing	Irrigate prior to the preferred sowing date. Aim to have at least 60 cm of wet soil at sowing.
Pre-sowing weed control	Trifluralin is essential for early grass control. Consider using a knockdown herbicide before sowing.
Inoculation	Inoculate within 1 day of sowing. Keep inoculated seed cool at all times. Do not add seed coats or dressings that could kill rhizobia.

Sowing and establishment checks

Sowing date	Aim to sow within 3 days of the suggested time for your area.
Seed quality	Test germination just before sowing at an approved lab. Only use seed with >80% germination and low levels of deformed seeds.
Determine sowing rate	Use the sowing rate formula to make sure the correct rate is used.
Sowing depth	Sow into moisture at a depth of 3–5 cm.
Establishment	Consider re-sowing if less than 30 plants/m ² emerge.
Post-emergent weed control	Apply Group A herbicide 10–20 days post-emergent. Apply Spinnaker® 15–30 days post-emergent.



Insect and disease checks

Insect scouting	Check weekly up to flowering and at least twice weekly from flowering to late pod fill.
Insect threshold	Insect thresholds are based on the standard techniques of beat cloth equivalents. Ensure your technique can be used against the thresholds.
Sclerotinia	Mid-flower to early pod (~55 days after sowing) is the critical time for sclerotinia. Monitor carefully after infection periods (i.e. rainfall events and high humidity). Treat high-risk crops with fungicide at the first sign of sclerotinia infection.

Harvest checks

Desiccation	Spray Roundup® PowerMax when 80% of pods turn yellow–brown.
Windrowing	Consider windrowing if crop is lodged. Do not windrow green crops, only defoliated crops. Do not windrow if there is any chance of rain falling on the windrow. Windrowing and harvest should occur within the same day.
Machinery hygiene	Ensure that all machinery (header, trucks, auger, etc.) used for harvest are free of contaminants.
Harvest	Harvest grain at 12%–15% moisture.
Header setting	Use a rotary header with slow drum speed.
Grain handling	Limit grain handling to reduce grain damage. Avoid using screw augers.

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The information contained in this publication is based on knowledge and understanding at the time of writing (November 2004). 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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