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Modern cotton farming in Australia has a proud history which stretches back to the 1960’s with the first crops planted near Wee Waa in New South Wales. For more than 40 years, Cotton Seed Distributors (CSD) has played a central role in the growth and development of a dynamic and vibrant agricultural industry, one which has become synonymous with innovation, sustainability, quality fibre and high yields.

Based in Wee Waa, CSD is unique in Australian agriculture. We are a grower owned and controlled organization which provides specialised support to Australian cotton growers where ever they choose to farm. CSD is focused on the development, production and supply of elite Australian bred cotton varieties, backed up in the field by a team of experienced agronomic and research staff.

The CSD Charter is an important part of what CSD is all about and is enshrined in our constitution. Put simply, the CSD Charter embodies choice and aims to offer growers leading variety choices which maximize their gross returns. Our platform of varieties and technologies are focused on delivering grower and industry needs.

CSD has a long term partnership with the CSIRO Cotton Breeding Team. This partnership has been very successful and continues to grow from strength to strength.

The cotton breeding program is diverse and is based on delivering growers high performance locally adapted cotton varieties either conventional or transgenic.

Research and extension is central to the cotton industry’s success and CSD is a leading provider of research and extension in the cotton industry. We invest heavily in targeted practical research for the benefit of growers and the industry.

Biotechnology has played a very important role in the cotton industry over the last 10 years. CSD has partnered with biotechnology providers such as Monsanto and Bayer to ensure that the Australian grower has access to these important traits. The challenge is to ensure that biotech traits are delivered to growers in locally adapted elite cotton varieties. These technologies will continue to be very important production tools for growers and CSD / CSIRO are making significant contributions to their current and future success in Australia.

CSD looks forward to working closely with new and existing growers offering our assistance with your cotton production challenges. We are here to support you with our practical experience, our research base and our unwavering commitment to the Australian cotton grower. We encourage you to consider becoming a member of CSD and avail yourselves of our extensive technical resources.

This booklet has been prepared by the highly experienced CSD Extension & Development team. For specific advice, please contact any of the CSD team.

Best wishes for a successful 2013/14 crop,

Stephen Ainsworth
General Manager - Commercial Operations
Cotton Seed Distributors
BED PREPARATION

Cotton does not like waterlogging or wet feet, so beds or hills need to be of sufficient height that they do not slump at the edges, and the furrow must retain sufficient capacity to move runoff water out of the field after heavy rainfall. Beds should be slightly oval shaped to avoid ponding in the bed centre. A well consolidated bed is less likely to slump, and will allow more accurate seed placement, and lessen the likelihood of seed sinking when irrigation water is applied.

Obviously, bed width is going to vary considerably between different farms. Most equipment would be set up to cater for the varying width. However, some cotton equipment especially pickers are a standard 2m wheel spacing, and passage on beds will occur during the picking operation.

For those growers that have bankless channel setup cotton can be grown on this field configuration as long as the field has reasonable drainage. Field slopes for cotton are normally around 1:1500 (0.065%). But more importantly is irrigation timing and water on and water off fields which will be discussed later.

FERTILIZER APPLICATION

The nutrient uptake for a 10 bale/ha cotton crop is likely to be approximately 200 kg/ha N, 40 kg/ha P, 90 kg/ha K, 20 kg/ha S and 5 kg/ha Zn. Pre-plant fertilizer needs to be placed about 15cm deep and 5 cm to the side of the row location. On narrower beds, it may have to go on the inside of the row.

Ideally, N application should be split to reduce potential losses from leaching or waterlogging should wet weather occur soon after planting. If this strategy is adopted, the balance needs to be applied within 40 days of sowing, before plants become too tall for machinery to pass without causing damage. Extra care is required to avoid cotton roots when DAP (Diapmmunium Phosphate) is used. Where urea is the nitrogen fertilizer, the field must be irrigated immediately following application; otherwise heavy losses may occur through volatilisation.

It is possible that boron (B), iron (Fe), copper (Cu) fertilizers may be required for cotton production in some fields in some years. A soil test prior to sowing will provide guidance. At this stage for these nutrients, the same critical values and test methods used in southern Australia are recommended (see NUTRIPak).

NEIGHBOURHOOD COMMUNICATION

Cotton is particularly sensitive to the phenoxy herbicides (2,4-D's), suffering growth distortion, fruit loss and delayed maturity from even very small concentrations drifting onto the crop. It is important to talk to your neighbours, particularly those within a couple of kilometers about your planting intentions with cotton.

As well, it is critical to decontaminate any ground rig equipment that has been used for application of phenoxy herbicides before the start of the cotton season. A check needs to be made with aerial applicators to ensure their decontamination has been adequate. Full details on how to decontaminate equipment is available on the labels of these products. All rubber hoses, o-rings, gaskets and seals should be replaced as phenoxy herbicides can be drawn back into solution by some solvents used in other chemical products.
KEY COTTON VARIETIES FOR SOUTHERN NSW

Cotton varieties have been grown in Southern NSW over the last two decades in various transgenic technologies. Since the introduction of Bollgard II® and Roundup Ready Flex® varieties we have seen some great results which have shown consistency from a yield and quality point of view.

The following is a list of attributes of current varieties for Southern NSW. Variety recommendations are based on yield, quality and disease resistance.

SICOT 71BRF

Sicot 71BRF is a full season variety which is well adapted to most growing regions including southern NSW. It has good yield potential, stable micronaire and good fibre length better than the previous Sicot 71BR. It has performed well at Hillston as well as the Griffith and Murrumbidgee growing regions.

SICOT 74BRF

Sicot 74BRF is a full season variety with exceptional fibre characteristics. This coupled with a high yield potential and good Verticillium and Fusarium Wilt ranking makes it a good companion variety to Sicot 71BRF. This is Sicot 74BRF first season of CSD strip trials in Southern NSW.

SICOT 43BRF

Sicot 43BRF is a relatively early maturing variety with a compact growth habit. It is a smaller plant type than the previous Sicot 43 BR. It is seen as a companion variety for Sicot 71BRF in Southern NSW and could be used as a late plant option.

TECHNOLOGY OPTIONS AVAILABLE FOR SOUTHERN NSW

<table>
<thead>
<tr>
<th>Technology Class</th>
<th>Variety</th>
<th>Full Season</th>
<th>Late Plant</th>
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</thead>
<tbody>
<tr>
<td>Bollgard II® Roundup Ready Flex®</td>
<td>Sicot 71BRF</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sicot 74BRF</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sicot 43BRF</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Bollgard II® Liberty Link®</td>
<td>Sicot 70BL</td>
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</tr>
<tr>
<td>Roundup Ready Flex®</td>
<td>Sicot 71RRF</td>
<td>✓</td>
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</tr>
<tr>
<td></td>
<td>Sicot 75RRF</td>
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<tr>
<td>Conventional</td>
<td>Sicot 73</td>
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### Southern NSW Data

SEE LONG TERM AVERAGES ON PAGE 30

**Jock Coupland “Wardry” Condoblin**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield (bales/ha)</th>
<th>Yield (bales/ac)</th>
<th>% of Sicot 74BRF</th>
<th>Length (inches)</th>
<th>Manual Class</th>
<th>Mic</th>
<th>Strength</th>
<th>Turnout (%)</th>
<th>Uniformity</th>
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<tbody>
<tr>
<td>Sicot 75BRF</td>
<td>12.17</td>
<td>4.93</td>
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<td>30.6</td>
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**Mick Storrier “Hunthawang” Hillston**

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<th>Yield (bales/ac)</th>
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<th>Length (inches)</th>
<th>Manual Class</th>
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**Mal Prichard - Twynam “Merrowie” Hillston**

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<th>Yield (bales/ac)</th>
<th>% of Sicot 74BRF</th>
<th>Length (inches)</th>
<th>Manual Class</th>
<th>Mic</th>
<th>Strength</th>
<th>Turnout (%)</th>
<th>Uniformity</th>
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**Roger & Tim Commns “Karwar” Griffith**

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<th>Yield (bales/ac)</th>
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<th>Length (inches)</th>
<th>Manual Class</th>
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<th>Strength</th>
<th>Turnout (%)</th>
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**Glen Rorato “Dunoon” Jerilderie**

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The Australian cotton industry has had experience with the use of genetically modified cotton since 1996 when Ingard® Cotton was introduced. Since then there has been extensive trialling and use of other technologies that have had enormous benefits for the environment and the industry.

BOLLGARD II®

Conventional cotton is very susceptible to severe damage from Helicoverpa (namely Heliothis Armigera and Heliothis Punctigera) caterpillars. Helicoverpa moths lay eggs on the plants, these hatch into larvae in around 3 days and commence feeding on plant material. Left unchecked they can devastate entire crops very quickly. Regular and complete checking by experienced cotton scouts can determine the level of helicoverpa in a cotton crop and the amount of damage. Once a determined threshold is reached control is needed. Monitoring egg lays to spray the eggs prior to hatching has been quite effective to kill the eggs prior to hatching. Continuous use of particular insecticide groups has led to helicoverpa developing resistance to these compounds with which has had serious implications for effective control of these common pests.

As a consequence of continued spraying and the development of increasing levels of resistance to chemical compound groups the Australian cotton industry introduced Ingard® cotton in 1996. Ingard cotton was developed by Monsanto and it contained a single gene from the naturally occurring compound, Bacillus Thuringiensis, which when ingested by helicoverpa caused rupturing of their gut and subsequent death. The product only contained one gene, Cry 1AC, and therefore the possibility of Helicoverpa developing resistance to the protein was, and still is, a very real concern.

Ingard cotton had an effective period on control of around 100 days from emergence. Complete monitoring of the crop was, and still is, critical to assess insect levels and types to then make decisions for control if required. The establishment of refuges is a key component of the ongoing success of GM cotton. Moths from these non sprayed refuges mate with any escapes from GM cotton areas to continue to delay the possibility of resistance to the proteins toxic to helicoverpa.

2004 heralded the introduction of Bollgard II cotton from Monsanto. There was a rapid changeover (one season) from Ingard to Bollgard II. Bollgard II contains two genes for control of Helicoverpa and other lepidopteran pests (Cry 1 Ac and Cry 2 Ab). The introduction of Bollgard II has helped reduce the amount of chemicals applied to cotton with astounding benefits to the environment, resistance buildup and the industry as a whole. Bollgard II has been shown to provide effective control of Helicoverpa and similar pests for the length of the season, although this in no way replaces the need for regular crop scouting, monitoring and management.

Maintaining effective refuges, ploughing down of crop residues to prevent the emergence of heliothis moths from under the ground and complete in crop monitoring of pest levels are critical to the longevity of this key product. It is vital to employ the services of an experienced cotton consultant to monitor pest levels to determine if additional control is required. Consultants can also advise on many other aspects of cotton production.

Growers need to obtain a Technology User Agreement (TUA) from Monsanto before they are able to grow Bollgard II cotton. A TUA is a legal document and outlines the grower’s responsibilities. A TUA must be established before seed containing Bollgard II can be purchased or planted. An license fee is payable to Monsanto for use of the technology which is all covered in the TUA.

Bollgard II allows growers to now manage for high yielding crops with less concern for Helicoverpa control. CSD has a diverse stable of Bollgard II varieties either alone or ‘stacked’ with Roundup Ready Flex technology.

ROUNDUP READY® & ROUNDUP READY FLEX®

Roundup Ready cotton was introduced to the Australian cotton industry in 1999 by Monsanto and has become an important part of weed control practices in cotton. To put it simply, Roundup Ready cotton can be sprayed ‘Over the Top’ with Roundup Ready Herbicide before the 5th true leaf. The plants continue to grow and develop in the presence of glyphosate with no affect on early vegetative growth. Prior to this weed control relied solely on traditional control methods such as:

- Chipping of weeds by chipping crews
- Inter row cultivation
- Pre emergent herbicides applied prior to planting
- Post emergent herbicides applied after planting
- Shielded and directed spraying and
- Laybye spraying (applying a residual herbicide just prior to row closure)

Because there is a narrow herbicide application before the fifth leaf stage of the crop (The Emerald area can be as little as 18 days after emergence) there is a need for other weed control options including
some or all of the above. Spraying Over the top after the fifth leaf stage can severely affect the reproductive or ‘fruiting’ cycle of the plant with potential reductions in yields. The possibility of resistance to glyphosate is a real concern and there is a Crop Management Plan (CMP) in place to monitor weed control, species present and the control of any ‘weed escapes’.

Roundup Ready cotton has been a significant improvement in weed control options and it has been very effective in helping cotton growers control large populations of weed species early in the season when the crop is very susceptible to competition from weeds.

The introduction of Roundup Ready Flex (RRF) cotton in 2005-06 has been a quantum leap in weed control for cotton in Australia. RRF cotton was developed by Monsanto and can be sprayed with Roundup Ready Herbicide ‘over the top’ up until the 16th Node. After this stage it can then be applied as a ‘directed’ spray to control weeds along and within the plant line under the main crop canopy. If needed, late emerging weeds can also then be sprayed ‘over the top’ through defoliation leading up to picking.

Other methods of weed control including pre and post emergent herbicides and laybye spraying can still be incorporated in an integrated weed control program. Fields that are particularly weedy should have additional control methods in place.

Using broadacre booms for weed control for spraying over the top for a lot of the season means there are significant savings in time, labour and machinery costs. Head ditches, tail ditches and sides of fields can also be sprayed. Care must be taken when spraying close to susceptible crops as Roundup Ready Herbicide is non selective.

As with Roundup Ready cotton there is a Crop Management Plan that must be adhered to to prevent any weed species becoming resistant to glyphosate which is a group M herbicide. Growers intending to plant varieties with RRF technology must also have a TUA with Monsanto. RRF is available in several key CSD varieties either alone or stacked with Bollgard II. The availability of ‘stacked’ varieties with Bollgard II and RRF has helped make growing successful cotton crops more viable.

LIBERTY LINK®

Liberty Link cotton from Bayer Cropscience is available in CSD varieties only. It is registered in all cotton growing regions. As with other transgenic cotton, growers are required to establish a TUA to be able to use this technology.

Liberty Link cotton is tolerant to the top applications of Liberty 200 herbicide. It is not tolerant to glyphosate.

Liberty 200 Herbicide has a different mode of action when compared to glyphosate. It is a Group N compound and there is no known cross resistance with glyphosate. Liberty herbicide contains glufosinate ammonium and 30% surfactant.

It will offer cotton growers many benefits including:

- Another option for weed management and to reduce the risk of resistance
- Control of RRF volunteers
- Improved control of hard to kill broadleaf weeds including peach vine

Liberty Link (LL) cotton can be sprayed over the top all season but there is a 70 day withholding period prior the harvest. The herbicide has some application parameters which must be be considered including the following:

- Do not apply at temperatures over 33°C
- Do not apply when the relative humidity is below 50%
- Apply in a minimum of 100lt water/hectare.
- Fine to medium droplets (200-300 micron) are recommended for most applications
- Do not add wetters or crop oils to the spray.

Liberty Link is available alone in three CSD varieties. Two of the varieties are straight Liberty Link varieties. The third variety Sicot 70BL is coupled with the Bollgard II® technology.
PLANTING

Many experiments have been done to determine the ‘ideal’ plant population for cotton. Southern NSW regularly uses higher planting rates due to cooler than average planting windows and the threat of seedling diseases causing reduced plant stands. What you want to avoid are **GAPS GREATER THAN 50cm** so use a higher seed rate if you can’t guarantee uniform seed placement.

**HOW MUCH SEED DO I NEED?**

The key considerations when determining how much seed you need is your desired plant stand, the seed size and seed quality for the variety you are growing, and how many seeds survive. On average there are about 10,000 seeds/kg however there will be slight differences between varieties. The average seeds/kg for each variety is printed on the bag and also available on the CSD website.

**SEED QUALITY**

All CSD seed has a minimum germination of 80% at the point of sale (most is a lot higher than this). Germination percentages for individual lots are available on the CSD website (www.csd.net.au) or contacting CSD’s lab (02) 6795 0000.

Seedling survival is rarely 100% so you can never bank on seeds/ha and plant/ha being the same.

**BED CONDITION**

Uneven or cloddy beds can result in uneven seed depth and seed/moisture contact, resulting in a staggered germination and gaps.

**SEEDING RATE CALCULATOR**

<table>
<thead>
<tr>
<th>Plants per metre of row, plants per hectare</th>
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<tbody>
<tr>
<td>Row Spacing</td>
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<tr>
<td>Plants/m</td>
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<tr>
<td>----------</td>
</tr>
<tr>
<td>10</td>
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<tr>
<td>12</td>
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<td>14</td>
</tr>
<tr>
<td>16</td>
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<td>18</td>
</tr>
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</table>

**SOIL INSECTS**

Soil insects, particularly wireworm, can attack young seedlings. Seed treatment insecticides will control them but because the insect needs to feed on the plant before it dies, some plant loss can still occur.

**SOIL TEMPERATURE**

Ideal soil temperatures for cotton establishment are 16°C - 28°C. Temperatures below this result in slow emergence and increased chance of soil diseases. Many of these factors are unavoidable and the best way to manage them is increase the seeding rate.

Cotton seed arrives to you in 20kg bags.
PLANTING DEPTH

The depth you want your seed depends on the method you are intending to establish your crop. Many people like to use the ‘knuckle’ as a quick and easy measurement tool in the field.

<table>
<thead>
<tr>
<th>Establishment Method</th>
<th>Ideal depth</th>
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<tbody>
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<td>Planting into moisture (rain or pre-irrigated)</td>
<td>2 ½ and 4 ½ cm</td>
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<tr>
<td></td>
<td>1 to 1 ½ knuckles</td>
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<tr>
<td>Planting Dry and Watering Up</td>
<td>2 ½ cm</td>
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<tr>
<td></td>
<td>1 knuckle</td>
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PRE-IRRIGATION OR RAIN MOISTURE

If the beds are too wet at planting, you end up with a shiny, smeared slot which is very difficult for the young roots to penetrate. The result is often young seedlings dying from moisture stress, even if there is plenty of moisture down below.

Check the consistency of the soil above the seed. If the pressure from the press wheels on the planter are set too high, you can get a compacted zone above the seed and the young seedling will have a tough time getting out.

While some dry soil above the seed slot is useful to prevent losing moisture from around the seed, however if there is too much, a rainfall event after planting will turn this dry soil into wet soil, and increase the depth for which the young seedling needs to push through.

WATERED UP

If the seed is shallower than 2½cm and the plant doesn’t have the chance to scrape off the seed coat at germination and growth of that plant will be quite slow until that coat is thrown off. When planting dry, it’s very importantly to be aware of the consistency of the seed bed. A poorly consolidated (or cloddy) hill can collapse when the water hits it and dropping the seed down to great depths, resulting in a poor or variable strike.

- Sowing can be followed by an over-the-top application of Roundup Ready® herbicide, targeting newly emerged weeds.

DO I NEED TO REPLANT?

The decision as to whether to replant or not is sometimes a straightforward decision, and other times not.

The obvious question is “will I achieve a better result with the plants I’ve got or should I start again?”

**Figure 2:** demonstrates the relative potential yield of plant stands that are variable or non-uniform compared with a uniform stand. A plant stand with high variability is described as one having 2 or more gaps greater than 50 cm in length every 5 metres of row. The data also shows that 5-10 plants/m of row has the best yield potential; variable stands will reduce yield for all plant populations.

Remember, any replanting needs to be completed within the planting windows for Bollgard II.
Cotton, like most field crops can be attacked by a range of insect pests during the season. For this reason it is very important to employ an experienced agronomist to regularly monitor the crop and help you make pest management decisions.

While there are many products registered for various pests; many insecticides, if used at the wrong time can cause more problems than they solve because they kill the ‘good bugs’.

The following table shows the most common pests of cotton in Southern NSW and a summary of where you’re likely to find them and whether they are controlled by Bollgard II®

<table>
<thead>
<tr>
<th>Pest</th>
<th>Crop Stage</th>
<th>Where found</th>
<th>Does Bollgard II® control is</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helicoverpa spp. (Heliothis)</td>
<td>Emergence to harvest</td>
<td>Attacks fruit and terminal buds</td>
<td>Yes</td>
</tr>
<tr>
<td>Silverleaf Whitefly (Bemisia tabacci)</td>
<td>All season, mainly at the end</td>
<td>Underneath leaves. Secretes honeydew.</td>
<td>No</td>
</tr>
<tr>
<td>Cotton Aphid (Aphis gossypii)</td>
<td>All season</td>
<td>Underneath leaves. Secretes honeydew.</td>
<td>No</td>
</tr>
<tr>
<td>False Wireworms (Saragus spp)</td>
<td>Planting and emergence</td>
<td>Underground feeding on emerging seedlings</td>
<td>No</td>
</tr>
<tr>
<td>Thrips (various species)</td>
<td>Emergence til squaring</td>
<td>‘rasps’ leaves of young seedlings</td>
<td>No</td>
</tr>
<tr>
<td>Green Mirid (Creontiades dilutus)</td>
<td>During boll filling</td>
<td>Attacks fruit and terminal buds</td>
<td>No</td>
</tr>
<tr>
<td>Rutherglen Bug (Nysius Vinitor)</td>
<td>Emergence til squaring</td>
<td>‘rasps’ leaves of young seedlings and attacks young fruit</td>
<td>No</td>
</tr>
</tbody>
</table>

If you want to know more about pest management in Cotton:

- IPM Guidelines for Cotton. www.cotton.crc.org.au
- Cotton Pest and Beneficial Guide www.cotton.crc.org.au

*Right: Cotton lint and leaves covered by honeydew, caused by silverleaf whitefly.*
Roundup Ready® herbicide, the registered formulation for use in Roundup Ready Flex cotton is a good product for Southern NSW for a number of reasons. The Roundup Ready herbicide, in conjunction with Roundup Ready Flex varieties allows for over the top application up to 16 nodes or well into December. Refer to the herbicide label for specific product rates, weeds controlled, application guidelines and use restrictions or talk to Monsanto.

It is very important however to incorporate other weed management tools into a strategy to minimise the risk of glyphosate resistance.

PRE-PLANT

Good management of weeds over the wet season prior to sowing is essential to reduce the weed seed bank. Cultivation, combined with the use of knockdown herbicides (e.g. glyphosate and paraquat/ diquat) will control weeds in the period between killing the cover crop and cotton sowing.

PLANTING

Roundup Ready herbicide provides excellent control over the main weeds that are likely to compete with young cotton; pigweed and small seed grasses. In some cases, however, it may be appropriate to use an application of pendamethalin (Stomp®) with the planter, particularly in fields with a history of high weed pressure. It also provides some insurance in cases when weather conditions prevent a Roundup Ready herbicide application early in the season.

IN-CROP

While Roundup Ready herbicide provides good in-crop control of most weeds, there are some occasions where you may need to incorporate other tools. This is particularly the case in high weed density situations, or if the Roundup Ready herbicide application has had to be delayed due to weather conditions, allowing some ‘hard to kill weeds’ (e.g. vines) to develop to a size where alternative control measures are needed. In these cases a ‘layby’ or directed application of a residual product may be necessary.

Your weed management strategy should be an ongoing discussion with your agronomist.

Refer to your Roundup Ready Flex® technical manual and the herbicide label for more details on this product.
DISEASES OF COTTON

A disease occurs when a pathogen is exposed to a susceptible host variety and the environment is favourable for an infection to take place.
A disease can be controlled by excluding or eliminating the pathogen, growing a resistant variety or by modifying the environment.

THE PATHOGEN

If pathogens are not present in an area - then DON’T introduce them! Several of the worst diseases of cotton are caused by pathogens that can be carried in dirt and crop residues attached to vehicles and machinery. Always practice good farm hygiene. Insist that vehicles and machinery, and even boots, are cleaned before leaving a farm - so that they are clean when arriving at the next farm. “COME CLEAN - GO CLEAN”

The only fungicides registered for use on cotton in Australia are seed treatments for the control of the seedling disease complex that causes pre-and post-emergent ‘damping off’ of seedlings. All cotton seed in Australia is supplied with a standard fungicide seed treatment.

THE HOST

All Australian cotton varieties are completely resistant to bacterial blight and have some resistance to Fusarium wilt, Verticillium wilt and Alternaria leaf spot. Our varieties are not resistant to the new races of blight in Africa, the viruses that have caused major problems overseas, nematodes and many of the fungal pathogens that can attack cotton.

Seed treatments are available that can ‘turn on’ the cotton plant’s natural defense mechanisms and provide increased resistance to some pathogens.

Crop nutrition is also important. Cotton plants that are deficient in Potassium are very susceptible to Alternaria leaf spot.

THE ENVIRONMENT

The environment can be manipulated by adjusting the planting date so that boll opening and cotton picking occur at the driest time of the year and fibre damage and down-grading are minimised.

Good crop management to prevent tall rank growth can significantly reduce the incidence of boll rots that thrive in the humid environment of a dense canopy.

Wet weather is usually a significant factor in disease development. There are several leaf pathogens that can infect cotton and cause various leaf spots, and even defoliation, when a maturing crop is exposed to an extended period of wet weather.

HELP IS AVAILABLE!

If you see something unusual. If you need help with a disease problem contact:

Dr Stephen Allen
Australian Cotton Research Institute
Narrabri, NSW 2390
Phone: (02) 6799 1530
Email: Stephen.Allen@csiro.au
SENDING A SAMPLE FOR DIAGNOSIS BY A PATHOLOGIST

(Associate a completed copy of this form to each sample)

Collected/Submitted by __________________________________________ Date collected __________________________
Address ______________________________________________________ Email __________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
________________________________________ Property & Field No.____________________________________
________________________________________ Grower’s address or area ______________________________________
____________________________________________________________________________________
________________________________________ Variety _____________________________________________
Grower/ Agronomist __________________________________________

DISTRIBUTION

One field only
In several fields
In all fields
One variety only
Several varieties affected
Some rows more affected?
On lighter soil types
On heavier soil types
In poorly drained area(s)

INCIDENCE/SEVERITY

All plants
Scattered single plants
Scattered patches of plants
In a large patch (>5m)
In a small patch (1-5m)
In a small patch (<1m)
Plants dead
Plants defoliating
One to few plants only

THE CROP

Irrigated
Dryland/ Rain-grown
Seedling stage
Setting squares
Early flowering
Peak flowering
First bolls open
Defoliated
Ready to pick

Rainfall in the last 10 days
Average temperature range over the last 10 days
Date of last irrigation
Date of last cultivation

Any other information?
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

When sending samples
• Contact the Pathologist before sending the sample
• It is better to despatch samples early in the week rather than just before the weekend!
• Never wrap samples in plastic. Dry or slightly dampened newspaper is better!
• When collecting seedlings –dig them up rather than pull them out. Include some soil.
• Sections of stem (10-15cm) are usually adequate for wilt diseases.
The cotton plant is quite predictable in the way in which it grows and responds to the environmental or management factors that are applied to it. This section is a ‘step-by-step’ guide to how the plant develops, what to look for and the important management considerations for each growth stage.

**GERMINATION AND EMERGENCE**

*What happens?*

As soon as a cotton seed touches moist soil, it will take in (or imbibe) moisture and begins the germination process.

Emergence is the development stage when the two cotyledons (leaves) break the soil surface and unfold. The warmer the soil temperature, the quicker this will happen. In Southern NSW planting occurs when the first break of warmer temperatures occur, but generally colder conditions exist in early October. This results in slower emergence compared to the Northern valleys. Emergence is expected to occur 12-18 days after planting.

Achieving a uniform plant stand is the most important thing to be looking for at this time.

See ‘Planting Considerations’

*Things to talk to your agronomist about*

Whether an adequate plant stand has been achieved.

**STAGES OF PLANT DEVELOPMENT**

The cotton plant has an indeterminate growth habit, which means it puts its fruit on while it grows leaves and stem. This occurs over an extended period of time, not all at once. The pattern of development is very ordered with fruit development occurring sequentially both upwards from bottom to top fruiting branches, and also outwards on individual fruiting branches. The rate of fruit development is driven mainly by temperature and it can be predicted using a calculation known as day degrees, (see insert). This development can be monitored and diagrammatically recorded throughout the season.

There are two components of the growth of a cotton plant; vegetative and reproductive. Due to the indeterminate nature of the cotton plant the vegetative and reproductive growth occur in parallel. Good crop management aims to keep the reproductive and vegetative growth in balance, to maximise the number of mature fruit (bolls) at harvest. Certain parameters can be measured and recorded to help with management decisions for maximum yield.

The following diagram shows the average time of development of the fruiting sites for cotton. For example on this plant the fruit at the very top of the plant will start developing about 27 days after the first fruit at the bottom of the plant.

*Figure 3: Rate of development of fruiting sites on a cotton plant, adapted from Oosterhuis 1990*
In the development of a cotton boll, the fruiting structure goes through three distinct phases.

**SQAURING**

**What happens**

The appearance of the first square is the beginning of the reproductive phase of growth of the cotton plant. Normally this occurs on the 5-6th branch or nodal position above the cotyledons. In Southern NSW climate this will take place approximately 60-70 days post planting. As the plant grows, additional fruiting structures will emerge about every three days at the first position location on branches. The plant will add another node or mainstem leaf every 3-4 days.

**Things to talk to your agronomist about**

- Fruit retention. The cotton plant can lose fruit for all sorts of reasons, and this needs to be monitored. Fruit retention is the percentage of fruit retained. Ideally, fruit retention should be maintained at or above 60% during squaring, up till first flower.
- Make sure the crop is being regularly monitored for insects.

**Timing of the first irrigation**

- Applying too early can prevent the roots exploring deep into the soil producing a ‘lazy’ plant
- Applying too late can result in reduced plant size with a lower yield potential.

**FLOWERING**

**What happens**

In Southern NSW climate, flowering will normally occur 20-25 days after squaring (85-95 days post planting). The cotton flower is white, with five petal flowers and normally opens first thing in the morning. The cotton plant is usually self pollinating and this process occurs very shortly after the flower opens.

**Things to talk to your agronomist about**

- Fruit retention should be monitored during the entire flowering period, and growers should aim to keep this percentage above 60%.
- Nodes Above White Flower (NAWF) is a measurement to see whether the crop is still actively growing during the flowering period. At first flower, it is ideal to have greater than 7 NAWF to ensure the plant is growing at its optimum rate.
- The Vegetative Growth Rate gives an indication of whether the crop is becoming too vegetative (or rank) and provides an indication as to whether the plant growth regulator mepiquat chloride (e.g. Pix®) should be applied. Rankness can lead to problems later in the crops growth, such as shading of lower leaves, boll rots and disease outbreaks. As well as delaying crop maturity which is not desirable in Southern NSW.
Irrigation Management

Crop water use will be increasing rapidly. Moisture stress or waterlogging during this time can reduce fruit numbers by shedding fruit and stopping the plant from producing more. It can also impact on fibre quality, particularly staple length.

Insects: Make sure the crop is being regularly monitored for insects. A number of insects can effect the retention of squares, flowers and fruit on the plants. Since the introduction of Bollgard II the most common encountered pest requiring control are Mirids. This pest is a small sap sucking bug that damages squares and young bolls causing shedding. It is common for growers to control mirids several times during a season. These bugs can fly in on weather changes and therefore can turn up un-expectedly. Your consultant/agronomist will check for these regularly and advise action when needed. Other pests such as Rutherglen bugs, Aphids and silverleaf whitefly will also be monitored by your consultant during the squaring and flowering phase. Depending on circumstances control may be required for these secondary pests.

BOLL FILLING

What happens

After fertilisation, the boll or fruit begins to develop. The boll is divided into segments of capsules called locks. These contain the seed and lint. Typically the boll has 3 to 5 locks which contain 6-9 seeds.

The boll increases in size rapidly after fertilisation of the flower and reaches its full size about 20-25 days later. The length of the fibres is determined during this period, while the maturity or micronaire of the fibre is determined during the second half of the boll’s development, which takes in total about 50 days (seen in Figure 4).

Once mature, the boll will split and the cotton seed and fibre will expand out of the capsule to form a white fluffy bundle of seed and lint

Things to talk to your agronomist about

Irrigation management: Crop water use will continue to rise. Similar to flowering, this is the stage where moisture stress or waterlogging will have the biggest impact on yield and fibre quality, particularly staple length.

Insects: Make sure the crop is being regularly monitored for insects.

CUT OUT

What happens

‘Cut out’ is the term used to herald the appearance of the last effective flower at the top of the plant, or when all the fruit that you will attempt to harvest is on the plant. It normally occurs when the plant reaches about 4.5 Nodes Above White Flower (NAWF). At this point the crop has set all of its fruit and goes about the process of maturing the remaining bolls. In the Southern NSW climate this is expected to occur about 148 to 157 days post planting.

About this time the earlier set bolls will have started to open and measurements of ‘the number of nodes above the most recent cracked boll’ should be used to determine the date of the last irrigation and defoliation.

See ‘Timing of last irrigation and defoliation’ section

Things to talk to your agronomist about

Irrigation: Timing of last irrigation, defoliation, and picking. Crop water use will be slowing.

Insects: Make sure the crop is being regularly monitored for insects; particularly silverleaf whitefly and aphids which can secrete honey dews and contaminate the lint within the opening bolls.

Rainfall and humid weather as the bolls open can cause ‘boll rot’.

Figure 4: The fibre develops in length for about 18-24 days after flowering (temperature dependant). Shortly before this elongation stops, thickening of the fibre wall begins, and it continues for about 40 days or so, until shortly before the boll opens.
DAY DEGREES

Temperature has a major influence on the development of a cotton plant.

The relationship between plant growth and temperature for Australian conditions is described by the following equation.

\[
\text{Day Degrees} = \frac{(\text{Maximum Temp} - 12) + (\text{Minimum Temp} - 12)}{2}
\]

**Example**

Max temp = 30°C, Min temp = 20°C

\[
\frac{(30-12) + (20-12)}{2} = 13 \text{ Day Degrees}
\]

The average day degrees for vegetative and reproductive growth in Australia are shown in the table below compared to growing days at Hillston and Griffith.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Days at Hillston</th>
<th>Days at Griffith</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing to Emergence (80 DD)</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>5th Leaf (330 DD)</td>
<td>48</td>
<td>51</td>
</tr>
<tr>
<td>1st Square (505 DD)</td>
<td>66</td>
<td>69</td>
</tr>
<tr>
<td>1st Flower (777 DD)</td>
<td>88</td>
<td>93</td>
</tr>
<tr>
<td>Peak Flowering (1302 DD)</td>
<td>128</td>
<td>134</td>
</tr>
<tr>
<td>Open Boll (1527 DD)</td>
<td>148</td>
<td>153</td>
</tr>
<tr>
<td>60% Open Bolls (2050 DD)</td>
<td>203</td>
<td>220</td>
</tr>
</tbody>
</table>

*Figure 5: Time line of cotton crop development in Southern NSW*
IRRIGATION MANAGEMENT

Irrigation timing is critical in Southern NSW as timely watering encourages fruit development and strong plant growth.

Timing of irrigations

A balance is required to keep vegetative growth in check and also promote the development of new fruit to ensure the crop yield potential is reached. Excessive frequency of irrigation can lead to conditions suited to vegetative growth and ‘rank’ plants, which will create problems later in the crop’s life such as shading and a humid canopy environment.

First irrigation

This is one of the hardest irrigations to schedule. The key to the timing of this irrigation is to avoid stressing the young crop but also ensuring that the plants’ root system is sufficiently expanded to allow full exploration of the soil later in the crop’s life. Aim to have the soil profile full in the lead up to first flower, encouraging crop growth during this critical stage of the plant’s development and ensuring the NAWF value is high (7-8).

Further Irrigations

Schedule irrigations to coincide with about 50% Plant Available Water Capacity (PAWC). In warm or hot conditions, the irrigation interval may need to be shortened to address the increased demand from the plant and to limit plant stress. During the flowering and boll filling periods of the plant’s growth, water use increases. This period is the most critical especially with BollgardII® cotton to ensure that the plant does not suffer from moisture stress which can negatively impact on yield and also have detrimental effects on the fibre quality of the cotton.

Reduce the likelihood of waterlogging by keeping an eye on the outlook for rainfall. Cotton responds poorly if irrigation is followed up by reasonable quantities of rain, which waterlog the crop.

Application of foliar Nitrogen fertilisers before a likely waterlogging event has shown some reduction in yield loss from subsequent waterlogging on some occasions. Ensuring that water is removed from fields, thereby shortening the waterlogging is the best way to minimise the problem.

The duration of the irrigation event should be minimised to assist in lessening the duration of waterlogging. The use of larger syphons has been shown to push water through the rows and reduce the time a crop has water running through it. This is all dependant on the slope of the soil, the length of the field and the soil type. Black cracking clays typically are more prone to waterlogging.

Symptoms of cotton plant in moisture stress

The first sign of moisture becoming limiting to a cotton plant is the gradual reddening of the main stem towards the growing terminal at the top of the plant. As the soil moisture potential declines the main stem turns from a light green colour to a reddish maroon colour which will progress up the plant. Irrigation to minimise stress on the plant should coincide with the reddening reaching the terminal.

A decline in the NAWF is also a sign that the plant is experiencing stress. Care should be taken especially during the early flowering period to keep the NAWF value above 7, and above 5 during mid to late season.

Further stress is indicated by a darkening of the shade of green in the leaves. In severe stress situations the leaves appear almost blue in colour. Water stress of this level will result in yield decline.

Physical wilting of leaves is another sign of moisture stress, with leaves appearing limp and leathery and losing all turgor. This can sometimes be confused with midday wilt, where the cotton root system cannot supply enough water to meet transpiration demand. This is common on hot days especially on lighter textured soils.
TIMING OF LAST IRRIGATION & DEFOLiATION

In the latter part of the season, the decision will need to be made on how many more irrigations crops will need and when to time the final irrigation so that all the bolls you aim to harvest reach full maturity with adequate moisture.

The prime objective of the last irrigation is to ensure that all bolls are matured without water stress. The broad aim is to have the soil reach refill point by defoliation. At the time of last irrigation all bolls have been set, vegetative growth is limited and the majority of plant carbohydrates are being used to satisfy boll demands.

Once a boll reaches 10-14 days old, the abscission layer that causes boll shed cannot form and it is for this reason that boll numbers are not significantly reduced by late water stress; however fibre development can be affected. Crops that come under stress prior to defoliation (at 70% open or 4 Nodes above Cracked Boll), can suffer some yield and fibre quality reduction. The level of reduction obviously increases the earlier the stress occurs.

The decision of timing of final irrigation, defoliation and products for defoliation are best done in consultation with an experienced agronomist. There are a number of methods available to accurately time final irrigation and defoliation:

Counting Nodes above Cracked Boll (NACB) is quick and common. It is assumed that cotton will open up at a rate of about node every three days. This will depend on a number of factors, particularly weather conditions. If the crop is maturing in the cooler month this will be much slower.

When the crop reaches 4 NACB, the top boll will have reached “effective” maturity, where fibre development on all bolls is complete and defoliation can occur without risk of reducing yield and quality. The following diagram explains some issues associated with measuring NACB.

Assuming the bolls open at 1 node every 3 days, the crop will reach 4 NACB in 12 days time. How far up the plant do you measure?

How far up the plant do you measure?

For the purpose of using NACB for timing of last irrigation and defoliation, we are only interested in determining how many nodes from the cracked boll to the last boll that you intend to harvest.

On the diagram the last harvestable boll is on FB 10, therefore you ignore FB 11-14.

Do you count nodes without fruit on them?

YES. All nodes between the cracked boll and last harvestable boll should be included. The maturity of the boll is dependent on its age. It takes the same amount of time for a boll to mature properly regardless of the presence of other bolls on neighbouring nodes or positions.

On the diagram, nodes 5, 7 and 9 have no fruit, but need to be included in the NACB measurement.
Measuring/Estimating Crop Water Use

When the number of days to 4 NACB has been determined, the amount of water the crop will require to reach that point needs to be addressed. This requires two key pieces of information:

- Soil Water Holding Capacity (SWHC) (the difference between full and refill point).
- The daily crop water use. Those with moisture probes can use real time data, while those who don't may have to estimate. Generally, daily crop water use will decline as more bolls open.

In our example crop, how much water would be needed and when could it be defoliated?

Current NACB is 8; hence 4 NACB will be reached in 12 days (assuming 1 node every 3 days).

If crop water use is assumed to be 5mm per day and we want to be at refill point at defoliation (4 NACB), this crop will require 60mm.

The number and timing of the final irrigation would then depend on the SWHC.

Above: The difference between mature (right) and immature bolls (left).
PICKING

Picking generally takes place once all bolls are open and cotton lint is dry and free of moisture. Seed generally is hard.

Picking can commence in the morning when the dew has gone and should finish when the evening dew settles on the crop. This is important as moist lint in modules can cause extreme heat to build up and can cause fire in modules.

PICKER MAINTENANCE

A simple checklist of maintenance and daily checks that should be carried out to ensure the highest quality picking.

Produced using information provided by a number of leading picker contractors whom we thank for sharing their advice.

PRE-SEASON MAINTENANCE

**Spindles**
- Replace bent or broken spindles.
- Check for sharpness by running your hand over them - good spindles will almost draw blood.
- Rotate top and bottom spindles, i.e.: 5 top and 5 bottom (similar concept to rotating car tyres to get even wear). Some operators replace bottom spindles with new ones.

**Doffers**
- Doffers need to be ground and properly set each year
- Check before each season:
  - Moisture pads/racks
  - Bar Heights
  - Rib Bars

**Picker Basket**
- Need to set grates properly to blow out trash
- Check compactor rams for oil leaks

**General**
- Check for hydraulic oil leaks (in mobile builders also).
- Flush tanks and filters (best done at the end of the season).
- Check the air supply is even from each head to prevent blockages (rats and wasps will often build nests in the air tubes).
DAILY CHECK LIST

Greasing

• After greasing (best done the previous evening when heads are still warm) spin the heads to throw off excess grease.
• Wash grease down.

Head Heights

• Compromise between being too low and picking up dirt and being too high and leaving bottom bolls.

Pressure Door Settings

• Tight and close.
• Back off until you get best cotton and least trash.
• A fair range of adjustments do the job; it is usually at the tight end that you get problems.
• After rain or frost the plant is more brittle hence there is a greater chance of bark.
• Dented or worn doors cause inefficient picking.

Heads/Spindles

Monitor heads continuously (every few dumps at least) looking for:

• Spindles that have not been wiped going past the doffer.
• Dirty spindles [wrap], the reason for this is usually being the water system of the picker; check this first then check the doffer.
• The need for additives in the water especially if there is green leaf.

Picker Door Cleaning

• A least every hour the doors should be cleaned to avoid a build-up of trash.

Basket

• Clean basket lid after every second dump (less often if there is not a lot of fly cotton).
• Tipping baskets need cleaning more frequently than elevating baskets.
• Cotton on top of the basket is very poor quality, this fly cotton not only causes quality problems but also creates a fire hazard.
• Don’t clean the basket and throw fly cotton where a module may be built.
MOISTURE

When to stop! (Rules of thumb)

- If you can feel moisture at all on bolls – STOP
- If moisture is evident on your vehicle you should be at home
- Blocked doors, throwing cotton out the front – STOP
- Cotton reaches 10% to 13% on moisture meter – STOP
- Cotton coming out as a dense blob and not fluffy – STOP
- Good picking conditions beyond 9.00pm are rare.

Consequences of breaking the rules.

- Spindle twist.
- Chopped out doffers.
- Blocked doors.
- Light spot ($15 - $20 bale discount).
- Moisture pad and doffer damage.
- Tonight’s gain is tomorrow’s loss with down time.
- Consequences not as bad in the morning as things dry out, therefore the risks are less in the morning than at night.

When to start (Rules of thumb)

- Hard seed (cracks in your teeth).
- Free moisture on the lint almost gone.

Adjusting water rates

- Operators should adjust water rates according to the time of day and picking conditions.
- Higher rates during the middle of the day will assist picking efficiency but rates should be reduced in the morning and evening or when lint contains higher levels of moisture.

TRASH IN THE SAMPLE

Three major reasons for trash in the sample:

- Poor defoliation
- Picking too early
- Poor picker set up

THE KEYS TO A QUALITY PICKING

- Cleanliness
- Contamination Free

“It doesn’t matter if you are picking with 622’s or 9960’s, all operators agree these are the keys to a quality pick.”
Along with yield, fibre quality is a major factor that determines the returns from growing cotton. Cotton is sold using lint values calculated by merchants. In Australia base grade (the standard by which premiums and discounts are applied) is cotton with 31 colour and 3 leaf. These grades are given by a qualified cotton classer by comparing cotton samples with known standards from the US department of Agriculture. Cotton with better colour (uniform white colouring) and less leaf contamination receives a small premium over base grade.

Other fibre characteristics are measured using a machine called a HVI (high volume instrument). It measures the fibre length, fibre strength and estimates the fibre maturity and thickness (micronaire). The standards for fibre length, strength and micronaire vary slightly from merchant to merchant but are summarised below.

**Base Grade**
- Length - 1.11 inch or 36/32nds
- Strength - 28 grams/tex minimum
- Micronaire - 3.5 to 4.9 mic units. (Premium range 3.8 to 4.5 mic units)

The quality of lint is influenced by many things. The environment, variety selection and crop management are the major factors influencing the quality if lint. The diagrams below indicate the relative importance of the various factors on fibre quality.

Colour is influenced mostly by rainfall after the boll has opened, but can also be affected by insect activity before and after boll opening. Leaf grade is largely impacted by the defoliation job. A good defoliation operation will reduce the amount of leaf trash in the sample. Your consultant will be able to suggest the best way to defoliate your crop.
Killing the Cotton Bush

Cotton is a perennial woody shrub, so effective measures must be employed post harvest to encourage rapid breakdown of plant remnants and also to prevent the stub plant from ratooning. Trying to kill stub (or ratoon) cotton in subsequent seasons can be difficult.

A combined mulching and root cutting operation is the best way of achieving the above goals.

The mulching must cut the above ground material into lengths no longer than 10-15 cm and also fracture the epidermis (plant skin), which will speed up the breakdown of the mulch when incorporated into the soil.

The root cutting operation must sever the tap root 10-15 cm below the soil surface. This will prevent the plant from growing again from the root, forming ratoon plants. It is not necessary to deep rip to remove the remnant root system. Any escapes from this root cutting operation will become a problem in the subsequent fallow or crop, as they are difficult to remove with normal tillage, and will not be killed by herbicides.

The soil must be reasonably dry for the root cutter to function effectively. Blades must be sharp and properly aligned. Mulchers function well over a wide range of conditions, although excessive regrowth may require the application of a ‘burndown’ herbicide to reduce the quantity of green leaf. For this reason, the mulching/root cutting operation should be conducted as soon as possible after picking.

Another technique used by some growers involves pulling the entire plant out of the ground and leaving it on the surface to dry down, before mulching or burning. This technique involves a longer time span and more operations, and usually produces an inferior final result.

Controlling Volunteer Cotton

Volunteer cotton, which originates from seed from bolls or locks which have fallen on the ground during picking can become a major weed in a subsequent crop. It is important to encourage germination of this seed as early as possible in the fallow. A shallow offset discing after the mulching operation will break up the bolls and produce the best conditions for germination. Once germinated, control is relatively simple with tillage or burndown herbicides.

Above: Volunteer cotton can be a problem in subsequent crops.
**A Glossary of Cotton Terms**

- **Boll**
  The fruit of a cotton plant. The woody capsule which contains the cotton lint and seed. Forms immediately after the flower petals have fallen.

- **Bollgard II®**
  A trademark of Monsanto Ltd. Cotton containing both the Cry1Ac and Cry2Ab genes from Bacillus thuringiensis.

- **Burn down**
  Rapidly acting herbicide that dessicates weeds. Paraquat/diquat (e.g. Sprayseed) is an example.

- **Cut-out**
  The date when the last effective flower has formed. Flowers formed after this date will not add to yield. Cut-out can be recognised in two ways:
  - nodes above white flower falls below about 4.5 and remains below 4.5; or
  - the squares per metre falls below about 50.

- **Degree day**
  The heat accumulation calculated progressively during the season to monitor the crop's progress. Daily sums are used to predict date of growth stages of cotton crops.

- **Defoliation**
  When a product is applied to a crop to remove leaves ready for picking.

- **First flower**
  The date at which there is on average one open flower per metre of row.

- **First square**
  The date when the leaf adjacent to the first square has unfolded on 50% of plants.

- **Fruiting site**
  The position on a plant where a fruit (square or boll) is formed. Can contain a fruit or an abscission scar.

- **Integrated Pest Management (IPM)**
  Pest control based on the integrated use of a range of strategies that can be used to influence pest numbers in a crop.

- **Layby**
  Herbicide application applied mid season, directed at the base of the plant. Can be a residual herbicide or one targeting weeds in the plant line.

- **Liberty Link®**
  A trademark of Bayer Cropscience. Cotton tolerant to Liberty® herbicide.

- **Mepiquat Chloride (Pix®)**
  Plant growth regulator applied to a crop to manage vegetative growth.

- **NAWF Nodes Above White Flower**
  The number of nodes above the topmost white flower in position 1. Usually the average of 5 plants at a sample point.

- **Pan evaporation**
  Evaporation as measured by the depth of water lost from the open surface of a standard evaporimeter. A useful tool for calculating watering schedules.

- **Plant Available Water Capacity (PAWC)**
  The maximum amount of water that a soil can hold in the root zone and later release to plant roots.
**Pre-irrigation**
When a field is irrigated prior to planting a crop.

**Refuge crop**
An approved crop planted as a component of a Bollgard II® resistance management plan to ensure production of heliothis moths which have not been exposed to Bt transgenes and hence are likely to be fully susceptible.

**Retention**
The percentage of fruiting sites that contain fruit (squares or bolls). Often expressed as P1 retention (the percentage of 1st position fruiting sites where fruit survive), or total retention (the percentage of fruit survival on all fruiting sites).

**Roundup ReadyFlex®**
Glyphosate tolerant plants containing the cp4 epsps gene by Monsanto. Allows for over-the-top application of Roundup Ready® herbicide.

**Square**
The flower bud on a cotton plant. First seen as a triangle of bracts.

**Tipping**
The loss of the terminal growing point. Causes the plant to develop multiple stems.

**Water-up**
The irrigation immediately following planting, if pre-irrigation has not been practised.

**Water use efficiency**
A general term relating to measurements of the efficiency with which available water is used to produce a crop. Includes measures of the efficiency of supply, application and conversion of water to cotton lint.
### Long Term Averages

#### Jock Coupland - Condoolin

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield/ha</th>
<th>Yield/ac</th>
<th>Turnout</th>
<th>% of Sicot 71 BRF</th>
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<tr>
<td>Sicot 74BRF</td>
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#### Mick Storrier - Hillston

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<td>104%</td>
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#### Mal Prichard - Hillston

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#### Roger & Tim Commins - Griffith

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<th>Yield/ac</th>
<th>Turnout</th>
<th>% of Sicot 71 BRF</th>
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</thead>
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<td>41.6%</td>
<td>103%</td>
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</tbody>
</table>
Leaders in the field

CONTACT YOUR LOCAL EXTENSION & DEVELOPMENT AGRONOMIST FOR MORE INFORMATION

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