Stress mitigation

Maximise ROI

Risk management

Yield potential

Stronger stand

Drive optimal yield potential & support industry growth
Develop a healthy root system that is protected against attack from establishment pests and diseases

Maximise yield potential and fibre quality

Increased return on investment

Improved water use efficiency

Achieve the desired plant population and a uniform plant stand

faststartcotton.com.au
The FastStart™ Partners

Cotton Seed Distributors (CSD Ltd) has been supplying quality cotton planting seed to the cotton industry since 1967. Formed through the vision of Australia’s foundation cotton growers, CSD remains committed to the success of today’s cotton industry.

CSD is a major investor in cotton breeding, research and development, having developed a long and successful partnership with the CSIRO Cotton Breeding Program. CSD’s objective is to deliver yield and quality outcomes to keep the Australian cotton industry at the premium end of the global fibre market by delivering elite varieties that are specifically bred and adapted to suit local growing conditions.

Please visit www.csd.net.au to find out more.

Syngenta is one of the world’s leading companies with more than 28,000 employees in over 90 countries dedicated to the purpose: Bringing plant potential to life. Through world-class science, global reach and commitment to customers, Syngenta delivers integrated solutions that bring together leading seed varieties, seed care and crop protection products with expert agronomic advice and technology that enables Australian growers to realise a greater share of their yield potential and to better manage risk.

Please visit www.syngenta.com.au to find out more.
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Introduction

High cotton yields are never guaranteed. However, if the crop has a strong start, obtaining yield potential is much easier. At first flower, the aim is to have a uniform plant stand of 8 to 12 plants/m that is vigorous with a healthy root system, is free of biotic stresses such as seedling diseases, insects and weeds, has optimal nutrition and adequate water and has good plant architecture and canopy cover.

**Advantages of a vigorous start to your cotton crop**
- Achieve desired and uniform plant population
- A healthy root system free from seedling insects and diseases
- Have a large and healthy canopy prior to flowering
- Avoid unnecessary delays that shorten the fruiting cycle
- Improved water use efficiency

**Benefits of a vigorous start to the cotton crop growth cycle**
- A good start, combined with ideal growing conditions for the remainder of the season (i.e. adequate water and optimal nutrition)
  - will allow the crop to reach its potential at harvest
- Improved fibre quality
- Greater net return per hectare and megalitre of water
FastStart™ is a collaboration between Syngenta and Cotton Seed Distributors (CSD). It combines world leading cotton genetics, chemistry and technologies to result in strong, healthy crop growth from the early stages up to flowering.

The FastStart™ research and development program is funded through a contribution from the sale of CSD seed treated with Syngenta’s cotton seed care range. It addresses key grower and industry challenges such as the control of insect pests and diseases, as well investigating complementary technologies to help drive yield potential and minimise risks associated with establishing cotton in Australia.

This FastStart™ Establishment Guide focuses on irrigated cotton production systems and provides practical information on the key management steps required to ensure growers achieve the optimum plant stand.

Rain-fed (dryland) cotton production has many similarities and CSD has specific information on dryland cotton production systems at www.acresofopportunity.com.au

*Prepared by the CSD Extension & Development Team in partnership with Syngenta Australia.*
The rate of development through the life of the crop follows a specific pattern. The rate of development and growth of the cotton plant, especially early in the growth cycle is driven mainly by temperature, affecting all plant physiological processes from the speed of water uptake by the seed and the rate of germination and emergence of the seedling, to the speed at which the crop reaches squaring and then flowering. Due to this predictability, it allows for management and monitoring to influence crop growth and development. Using the relationship between the rate of development and temperature, a measure of crop progress is described as day degrees.

When the temperature is below 12°C, cotton plant processes cease and the plant experiences what is termed as cold shock. During this time the plant’s development is retarded, thus slowing the overall growth and development of the young cotton plant. To ensure good early season growth, it is vital to limit the number of cold shock events to which young cotton seedlings are exposed.

In warmer climates, day degrees may over-estimate the development of the crop. As in the cooler climates where cool temperatures delay the development of the crop, so too can excessively hot temperatures (> 35°C), as the plant uses resources and energy to transpire in an effort to keep cool. Reduced leaf biomass and fruit shedding can result from high day and night time temperatures. The effect on the accumulation of day degrees of cold shock is not well understood at present.

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

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

Table 1.1 Average day degrees for vegetative and reproductive growth of cotton within Australia.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Day Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing to emergence</td>
<td>80</td>
</tr>
<tr>
<td>Growth to one node</td>
<td>40</td>
</tr>
<tr>
<td>Initiation of square</td>
<td>220</td>
</tr>
<tr>
<td>Sowing to first square</td>
<td>505</td>
</tr>
<tr>
<td>Square to flower</td>
<td>270</td>
</tr>
</tbody>
</table>
GERMINATION AND EMERGENCE

As soon as a cotton seed touches moist soil, it will absorb moisture and begin to germinate. Initially as the seed takes in moisture, it is most sensitive to cool conditions and this sensitivity decreases as the radical elongates, as shown in Figure 1.2 Emergence is when the cotyledons break the soil surface and unfurl. The warmer the soil temperature, the quicker this will happen. Seedling establishment is best if minimum soil temperatures in the seed zone are at least 14°C or above. At temperatures below this, seedlings grow slower and are more susceptible to seedling diseases and insect attack.

EARLY SEASON GROWTH

During early growth, the development of the cotton plant is driven principally by temperature. However, as the plant develops, the rate of development can be influenced by competition for assimilates from photosynthesis, sunlight and water availability.

After emergence the developing cotton plant is capable of producing a new node every 2 to 4 days (40 day degrees) but this rate of development is very much determined by temperature.

The initiation of squaring is determined mainly by temperature, but photoperiod and genotype also has an influence. Squaring can commence between nodes 4 and 10, but on average in Australia it occurs at node 7 (or at 505 day degrees).
DEVELOPMENT UP THE PLANT

The cotton plant has an indeterminate growth habit, which means it produces fruit over a period of time, not all at once. The rate of development can be mapped through the life of the crop and it follows a specific pattern. This growth is driven mainly by temperature and therefore we use the day degree calculation to monitor and predict crop development.

The two phases of cotton plant growth are the vegetative and reproductive growth stages. While these stages overlap the aim is to keep them in balance to produce the highest amount of cotton at harvest.

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 (and finish) developing about 27 days after the first fruit at the bottom of the plant.

Vegetative branches normally develop on the lower nodes of the main stem (nodes 6 to 10). A branch develops from a bud formed between the leaf and main stem node it is attached to. While vegetative branches do produce some squares, the process is slower and less efficient than the main stem fruiting branches. The number of fruit retained on vegetative branches is related to plant population and resources.

Fruiting branches normally commence between the 6th and 10th node depending on genetic varietal differences, plant population, temperature, water availability and nutrition. These branches are characterised by a zigzag growth from node to node and fruiting structures (squares) and associated leaf are at each axial of each node.

Figure 1.4 (Top) Influence of daily average temperature on the time taken to reach first square. (Bange CSIRO, 2014)

Figure 1.5 (Bottom) Rate of fruiting site development of a cotton plant, adapted from Oosterhuis 1990
Figure 1.6 In the development of a cotton boll, the fruiting structure goes through 3 distinct phases.

**A fruiting branch**
A fruiting branch will have a boll with a subtending leaf on the opposite side of the fruiting branch or a scar where the leaf has fallen.

A vegetative branch will have a boll but no leaf opposite and will be smooth stem with no evidence of a leaf.

**Square - the flower ‘bud’**
‘First square’ is the beginning of the reproductive growth phase of the cotton plant, seen on the first (lowest) fruiting branch. Initiation of this first square normally occurs at the time the true leaf on node four or five is unfurled. As the plant grows, additional fruiting structures will emerge at the rate of about one every three days (or 40 day degrees) for first position fruit which are those closest to the main stem.

**Flower**
The cotton flower is white, with five petals and normally opens first thing in the morning. The cotton plant is usually self-pollinating and this occurs very shortly after the flower opens. Once fertilised, the flower turns reddish purple and then desiccates as the boll begins to develop.

**Boll**
After the petals fall off, what remains is the fertilised boll, or fruit of the cotton plant. This boll grows in size developing the seed and fibre inside. At maturity the boll walls crack and the lint dries out into the ball of cotton.

faststartcotton.com.au
Ten Tips to get your Cotton off to a FastStart™

“Do everything precisely, on time and never later”

1. Prepare fields early
   • Create a firm well structured seed bed, free of weeds and impediments in the planting line

2. Don’t let nutrition be a limiting factor
   • Know the yield target you want to achieve
   • Test your soils and know your nutrient levels
   • Have a strategy for fertiliser application to achieve your goal

3. Select the right variety and seed treatment for your conditions
   • Know the seed quality before planting and adjust sowing rates accordingly
   • FastStart™ seed treatment to control insect pests and soil-borne diseases

4. Be ready to go, don’t let your planter let you down
   • Ensure the planter is level and all components are well maintained and operational

5. Plant when conditions are right
   • Make sure you have the green light for cotton planting this season

6. Planting is an important operation - do it once and do it right
   • Continuously monitor within fields, across fields and the property
   • Ensure planting speed, depth and pressure are correct for your situation
   • Use lubricant to assist seed flow

7. Select the desired plant population to maximise yield per hectare
   • Understand the impacts and adjust sowing rates accordingly for
     - Low soil temperatures
     - Establishment method
     - Seedling mortality
   • Planting a few more seeds is good insurance

8. Reduce competition and promote good early season growth
   • Control weeds early and when they’re small
   • Economic threshold for insect pests depending on the type of species, number and region

9. Adequate soil moisture status is critical in ensuring desired growth rates at first flower (first irrigation)
   • Closely monitor;
     - Soil moisture status
     - Crop growth and development rates
     - Temperature and rainfall forecasts

10. Have the crop growing healthy at first flower
    • Create strong plant architecture
    • Aim to have 8 to 9 nodes above white flower at first flower
Pre-Planting
Weed Management up until Planting

Keeping fields weed free during the fallow period is essential. In addition to being unsightly, weeds in fallows increase the weed seed bank, provide a green bridge for pests and diseases and rob the soil profile of moisture, leaving the moisture status of the planting zone uneven.

**ROTATION CROPS AND FALLOW**

A fallow or rotation crop offers an excellent opportunity to control weeds, drive down the weed seed bank, allows you to rotate chemistry and use alternative weed control methods to reduce herbicide resistance build-up.

Within the fallow, the aim is to reduce the weed seed bank, hence weeds should not be allowed to set seed. To do this, growers should

- Target weeds when they are small and most susceptible to herbicides
- Ensure areas surrounding fields including fence lines, roads, irrigation channels and tree lines are kept weed free
- Ensure any herbicide survivors are controlled using alternate methods to prevent them setting seed

Rotation crops are also a valuable tool for integrated weed management.

Winter and summer crops have the advantage of drying out the soil profile and allowing strategic cultivation to manage soil and weed problems. There is a wider range of herbicides available for use in rotation crops compared to cotton and some weeds are more difficult to control in cotton systems, but are easily managed with alternate herbicides in the rotation crop cycle.

This is particularly so in cereal crops where broadleaf weeds are easy and cheap to control. Retaining cereal stubble cover for as long as possible also reduces weed establishment, encourages more rapid breakdown of weed seed on the soil surface, boosts water infiltration and reduces evaporation.

It’s important to consider the plant-back period for crop rotation herbicides because they can limit the rotation options and also harm cotton germination, emergence and early season growth.
**PRE-PLANTING RESIDUAL HERBICIDES**

There are a range of pre and post-planting herbicides that can be used in the cotton system. The use of these products has diminished in recent years as the industry has adopted Roundup Ready Flex®.

Pre-planting residual herbicides have the **advantage** that they
- Can be applied anywhere from several weeks prior to planting, right up until the planting operation
- Can be effective for weeks and months post application
- Can be applied prior to known weed problems to control those weeds before they emerge
- Play an important role in the management of herbicide resistance, especially for glyphosate
- Can be less expensive than non-residual alternatives
- Can open up the window for further chemical applications and at lower rates if control is effective

Some **disadvantages** are that they
- Must be applied in anticipation of a weed problem although one may not occur
- Can damage cotton seedlings, reducing crop populations and retarding early season growth (under certain circumstances)
- May need to be incorporated into the topsoil for optimum activity. Adequate incorporation of some residual herbicides is achieved through rainfall or irrigation, but others require thorough cultivation, which may conflict with other farming practices
- Can prevent other crop choices if cotton is not planted or removed (low water supply, hail)
- Can incur additional costs
Field Conditions

In order to get the crop off to the best possible start, it is critical that the seedbed is in the best possible shape and condition. To achieve a successful, uniform establishment:

- The field needs to be uniform
- The stubble needs to be broken down or incorporated and removed from the planting line
- The seedbed needs to be free of weeds
- The soil tilth needs to be fine to enable good seed to soil contact
- In lighter soil types, growers should consider using rotary harrows to spread, level and break up stubble well before the planting process
- The seedbed needs to be firm but not hard (solid), at least firm enough to leave a slight foot print when walked on
- You should know the tolerance of your planter to the soil conditions you have

Waterlogging in both irrigated and dryland farming scenarios is a major impediment to high yields. It is critical that the field is of uniform grade and free of low spots that will cause water to pond. Adequate drainage in terms of slope and infrastructure is essential to get water on and off fields quickly.

KNOW YOUR SOIL TYPE

It is important to know your soil type because different soil types behave in different ways. For example, a clay soil will hold water better than a sandy soil, but will tend to be sticky and smear. Knowing what soil type you have will influence your management practices and ultimately how your crop will perform.

A simple test including aggregate size, dispersion index, texture test and moisture content can help you in determining the soil type and how it will behave.

STUBBLE MANAGEMENT

The benefits that come from having standing stubble in the zone of the emerging crop such as moisture retention, less erosion and protection from wind-blasting, can all be outweighed if, at planting, incorporated stubble impacts on plant germination and the final plant stand. Too much stubble can affect water infiltration, subbing up and impact on seed placement, as well as providing a perfect environment for disease.

There are generally two types of stubble, either cereal stubble after a fallow or cotton stubble in back-to-back fields. The amount of stubble is dependent on numerous scenarios. Large crops produce more stubble, low winter rainfall means less stubble breakdown and cultural practices such as stalk pulling or burning will influence how much stubble remains to overwinter. Regardless of how much stubble is left behind, it is important at planting that it is removed from the planting line. If not, ‘hair pinning’ of stubble in the slot or planter unit bounce can impact on seed placement uniformity and seed/soil contact.

Trash whippers are commonly used to remove stubble from the tops of beds and will allow discs to plant into friable soil, not over or into solid stubble.

faststartcotton.com.au
FIELD SCORES (IRRIGATED COTTON)

CSD has developed a field score ranking system which ranges from 1 to 5, with 1 being ideal for obtaining uniform plant establishment and 5 likely to result in patchy or poor establishment. A score of 5 would have the potential to delay emergence or create the possibility of a replant.

Field Score 1:
Stubble fully broken down, usually cereal not cotton stubble. Firm seedbed which will support the planter unit. Beds have been rolled or shaped. Weed free. Seed zone free of soil particle size > 2 cm.

Field Score 2:
Similar to field score 1 but presence of larger soil particles (up to 2 to 3 cm).

Field Score 3:
Presence of soil particles up to 3 to 5 cm. Some stubble mixed into seed zone. The odd weed and the bed not as firm as 1 and 2, slightly sinking when pressure is applied to the bed.

Field Score 4:
Presence of medium to large soil particles, up to 5 to 8 cm. Increasing amount of trash. No firmness to bed. Your feet start to sink when walking on bed. Starting to see cotton volunteers/fuzzy seed in back-to-back cotton situations.

Field Score 5:
Presence of large particles up to 10 to 15 cm. Large remnants of past crop residues. Weeds present. No soil structure within the bed. A lot of air gaps. Beds sink away when walking on them. Remnants of cotton butts still in planter row, volunteers and high fuzzy seed levels in back-to-back cotton situations.
**Fertility**

"Don’t let nutrition be a limiting factor"

The first part of a fertility program is to regularly have soil tested to ascertain the current nutrient status of both macro and micro-nutrients. Additionally, analysis of soil pH and organic matter is used to assist in measuring trends. Once analysed, the soil test results can be used to plan the fertiliser program for the cotton crop based on:

- Yield expectations, e.g. a 16 bale/ha crop will remove 216 kg N/ha (see Table 2.1)
- Soil nutrient status. Soil test results should be known well in advance of planting
- Soil type, e.g. sandy soils will leach nutrients more than clays
- Soil condition, e.g. compacted soils may have reduced rooting depth and fertiliser timing will be critical

In modern cotton growing systems, major crop nutrients such as nitrogen are applied as a split application. It is common practice that 60 per cent of fertiliser goes on prior to planting with the balance applied by various methods once the crop has established. This allows cotton growers improved flexibility to manage for yield potential and also to boost efficiency of recovery of applied nutrients.

In general, the first 60 days of a crop’s life will use up to 130 kg N/ha (see Table 2.1). It is therefore important to ensure that the crop has adequate nutritional loading from the start of the season.

Low rates of pre-applied nitrogen (particularly on back-to-back cotton) can lead to slow early season growth and can create a poor plant canopy and architecture leading into flowering. Very high rates of pre-applied nitrogen has the potential to produce excessive vegetative growth which will require growth management earlier than expected.

Fertiliser placement is very important because root burn can occur when some fertilisers are placed too close to the root system. It is recommended that nitrogen be applied 10 cm to the side of the plant line (Incitec). Phosphorus and potassium can be placed under the row, but far enough away not to cause root burn.
In general, assess the time of year that fertiliser is being applied and what product will be used as this will impact on where and how the fertiliser is placed.

The use of liquid fertilisers is another option early in the season to improve vegetative growth and can be used prior to a stress event such as waterlogging to offset any potential damage caused through this period.
Variety Selection

Variety selection is one of the most important management decisions in the cotton production cycle. A number of criteria need to be considered and the final selection(s) often involve some compromise. Seldom does a variety come out tops in every category.

Plant breeding and crop management improvements are combining to achieve yield gains of 1 bale/hectare/decade for Australian growers. Most of these gains have come from improved germplasm (48 per cent), the interaction between improved germplasm and improved crop/field management practices (24 per cent) and the balance of 28 per cent from improved crop/field management practices. The risk with selecting the wrong variety is that it can impact on yield and overall gross return as seen in Figure 2.4.

YIELD

Profitability of cotton farms is very dependent on yield as it outstrips the variable costs of production. Selected varieties must have high yield potential and also the ability to respond to improved management practices in the realms of irrigation and nutrition in particular. The Australian cotton production area can be divided into the three major zones of hot, warm and cool, based on seasonal accumulated day degrees or GDD (growing degree days). The relative yield performance of the current key varieties is consistent in the hot and warm zones, with a slight variation in the cool zone.

Figure 2.3 Where yield improvement has come from over the last 30 years. Shiming Liu, Peter Reid, Warwick Stiller and Greg Constable, CSIRO Plant Industry, Narrabri 2013.

Figure 2.4 (Below) Varietal yield difference and its impact on gross return.

Varietal Yield Difference (%) influence on Gross Return (price $450/bale)

Extra Return $$$/ha

- 10.0 b/ha
- 12.5 b/ha
DISEASES

The presence of soil-borne diseases on farms can influence variety selection. Plant breeders have successfully produced some varieties with improved levels of resistance to the major soil-borne diseases such as Fusarium Wilt and Verticillium Wilt (expressed as a disease resistance ranking). In fields where there are high levels of these diseases, farmers will generally seek to grow the highest ranked variety to reduce potential yield loss and reduce inoculum build up. Other key diseases the Australian industry experiences including Black Root Rot, Alternaria and Boll Rot which exhibit no differentiation in susceptibility in current varieties.

QDAF and NSW DPI conduct annual surveys for the presence and severity of the main cotton diseases. For further information, growers can contact Dr Duy Le, ACRI Narrabri or Dr Linda Smith, QDAF Brisbane.

FIBRE QUALITY

Fibre quality characteristics of the key varieties currently grown reflect the ultimate use for most of Australia’s cotton, namely in high quality yarns produced in high speed ring spinning mills in Asia. This cotton is often purchased for a premium as it consistently meets high quality characteristics. Management practices and regional weather patterns can often have more influence than variety on the fibre quality produced. However, there are some fibre quality characteristics where the interaction of variety and management practices can help ensure the best product is produced.

Fibre length: In fully irrigated situations, fibre length from all major varieties generally meets market specifications. In rain grown and semi-irrigated situations however, some varieties have the potential on occasions to produce fibre with length below base grade specifications (< 1.11 inches), thereby incurring a penalty.

Fibre thickness: Thickness and maturity of the cotton fibre wall can be an issue, with high micronaire (> 4.9) a feature of the current highest yielding varieties in hot seasons in the central production zones. On the other hand, in the cool zone, low micronaire can impact high yielding varieties in seasons with below average day degrees or late planting.

TECHNOLOGY CHOICE

Biotechnology has reduced the environmental impact of cotton production with less pesticide and residual herbicides used. Cotton growers have a choice of varieties with a combination of insect and herbicide tolerance as well as just herbicide tolerant and conventional options.

Bollgard® 3, Bollgard II® and Roundup Ready Flex® technologies provide Australian growers with simple tools to effectively protect cotton yields. The Bollgard® 3, Bollgard II® trait is an important tool in the sustainable management of Helicoverpa spp, one of the cotton industry’s most significant insect pests. Roundup Ready Flex® cotton is able to tolerate applications of Roundup Ready Herbicide® with PLANTSHIELD® in its vegetative and reproductive stages. Therefore, growers can apply Roundup Ready Herbicide® with PLANTSHIELD® in-crop to weeds when and where they appear with full season tolerance.
Other influences on variety selection include:

- What season conditions (short or long season) exists where you farm?
- Do I have enough water to provide a full allocation to this crop (semi-irrigated, dryland or full irrigation choices)?

By answering these questions you will come up with the varietal requirements for your circumstances. Your local E&D Agronomist can assist you in selecting the variety of choice. Contact them or visit [www.csd.net.au](http://www.csd.net.au)

<table>
<thead>
<tr>
<th>Variety</th>
<th>V.rank (Verticillium wilt)</th>
<th>F.rank (Fusarium wilt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bollgard II® stacked with Roundup Ready Flex®</td>
<td>Sicot 71BRF</td>
<td>107(6)</td>
</tr>
<tr>
<td></td>
<td>Sicot 74BRF</td>
<td>101(6)</td>
</tr>
<tr>
<td>Roundup Ready Flex®</td>
<td>Sicot 75RRF</td>
<td>88(5)</td>
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<tr>
<td></td>
<td>Sicot 812RRF</td>
<td>94(4)</td>
</tr>
<tr>
<td></td>
<td>Sicot 711RRF</td>
<td>102(5)</td>
</tr>
<tr>
<td>Conventional</td>
<td>Sicot 730</td>
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<td>Bollgard® 3 Roundup Ready Flex®</td>
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<td></td>
<td>Sicot 707B3F</td>
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</tbody>
</table>
Planting Seed Information

REQUIREMENTS AND QUALITY

Have your planting seed on-farm and ready to go. Discuss your requirements with your preferred supplier prior to planting in relation to quantities and timing to ensure you are not waiting for seed to be delivered.

Check delivered seed quantities match what was ordered and update germination and seed size information to fine tune planting rate. Cotton Seed Distributors takes great pride in providing the highest quality cotton planting seed. CSD also provides cotton growers and consultants with current information on seed quality to enable further refinement to the planting operation.

Prior to sale, cotton planting seed is subjected to analyses to provide quantitative information about its ability to germinate under laboratory conditions, using internationally accepted protocols (ISTA). Obviously, the laboratory cannot mimic the complexity of the field situation that the seed will be subjected to during germination and subsequent emergence, so seed germination information provides only a small component of the emergence pathway.

CSD has the ‘Statement of Seed Analysis’ information available on its website, with data provided on an Auslot basis as soon as possible following the completion of the seed testing process.

CSD has chosen to only supply finished goods seed data because this information accurately defines the cotton planting seed supplied to growers.
IMPORTANT INFORMATION IS ON THE BAG

Variety, technology, seed treatment. Although this may seem simplistic it is important to check to ensure that the correct seed goes into the correct field (green circle).

The Auslot number (red circle) is a critical number on the label. Information on germination percentages can be obtained by quoting this number to the CSD website. Knowing the actual germination percentage is useful in fine tuning planting rates. This information is available at www.csd.net.au/auslots

Ensure all farm staff are aware of the chosen variety and technology for each field. Confusion may occur due to similarly named and coloured varieties across different technology groups (e.g. Sicot 714B3F and Sicot 711RRF). CSD has tried to alleviate this issue by having the bag and seed colour identical, based on the technology type.

WHAT INFORMATION IS CONTAINED IN A ‘STATEMENT OF SEED ANALYSIS’?

The key initial information is specific analytical data for an Auslot, which includes the variety, Auslot number and the seed treatment, with all this information being obtained from the bag. The statement also gives the seeds per kilogram of the particular Auslot and the date of testing or production.

Data is also provided on seed purity, as well as mechanical damage, which is assessed on a 100 seed sample, assessment for physical defects or mechanical damage such as cracked or holed seed coat, or broken seed. Expected values are < 10 per cent, but can be higher.

All germination values reported are for the whole sample including mechanically damaged seed.

The standard ‘warm’ germination value is obtained by a regime of 20°C for 8 hours and 30°C for 16 hours, for 7 days. The accepted standard value for cotton planting seed is 80 per cent. To be considered germinated, a seedling must have a length from hypocotyle hook to radicle tip of no less than 40 mm and be free from abnormalities.

The cool germination test follows the same protocol basically, the temperature regime however being a constant 18°C for 7 days. The seedling characteristics must be exactly the same for a pass. The accepted standard value for cotton planting seed is 60 per cent.

Seed Vigour Index (SVI) has been discontinued by CSD and has been replaced with more meaningful data. Our long term goal is to determine a reliable, robust and informative seedling vigour test. We are working with CSIRO to develop such methodology appropriate to Australian cotton cultivars.

CSD provides both warm and cool germination data on all Auslots and that commenced in 2015. Our intent is to provide growers and agronomists with useful and relevant data to make informed decisions at planting time.

SEED STORED ON-FARM

Carry-over seed purchased in previous seasons may have different seed quality in the future and should be re-checked. CSD encourages growers with farm stored seed to re-test the germination to ensure seed viability and fine tune planting rates.
Planter Setup and Maintenance

Precision planters are now the predominant type of planter units in use and it’s critical to have them correctly setup and maintained.

Growers should ensure their planter is well serviced and operational well before planting time. Breakdowns can rob you of time and allow surface soil moisture to disappear. Keep a kit of spare parts (seed tubes, press wheels, scrapers, monitor cables, chains and nozzles) close by to allow for quick repairs. Planters should be calibrated for seeding rates as well as granular insecticide rates (if used).

Planting slot compaction occurs when planting into (excess) moisture and can produce a compacted face on both sides of the seed slot. This affects moisture uptake by the seed and can reduce plant establishment. If press wheel pressure is too high, this can also cause compaction in moist soil and the resultant crust can impact on the seedling trying to push through. Pull up and check the planter in every field, in particular when planting into moisture.

Alternatively, if press wheel pressure is not ideal and baking conditions follow planting, this can lead to rapid seed zone drying leading to the seeding slot opening, a term known as ‘Kinze crack’. The planting row should be covered with a thin layer of dry soil to insulate and keep the moisture around the seed, also slowing the rate of drying of exposed wet soil faces.

Issues arise when too much dry soil is swept into the seed slot, due to incorrect closing pressure causing poor moisture uptake by the seed. Conversely, rain post-planting can cause soil crusting with a thick impenetrable layer above the seed.

Operator training is important. Educate the operator so they have clear understanding of what the planting operations is trying to achieve and can highlight problems quickly. Additionally, they need an understanding of when to stop. During planting, regularly check seed depth and the condition of the soil around the seed. This is especially important when planting on rain moisture where you may get some in-field variability.
CHECKLIST - COTTON PLANTER SETUP

☐ Level The Planter
  • Horizontally/vertically level the tool bar or have it running slightly down hill
  • Parallelograms during planting should be horizontal to or slightly below tool bar height

☐ Check Bushings and Parallel Linkages
  • Reduce bounce and lateral movement in planter unit

☐ Drive Chains and Cogs
  • Remove kinks and ensure they are lubricated and running true

☐ Disc Openers
  • Ensure even wear and good contact
  • Ensure mud scrapers are on and aligned

☐ Calibrate Seed Rate and Meters
  • Ensure correct seeding plates and baffle is in the correct setting
  • Calibrate seeding rate and monitor performance

☐ Seed Tubes
  • Replace worn or faulty tubes
  • Ensure monitor sensor is securely fastened and cleaned

☐ Press Wheels
  • Replace redundant ball bearings and rubber tires
  • Ensure press wheels line up on planting disc slots
  • Ensure level across planter unit

☐ Trash Wipers
  • Rotate and replace redundant ball bearings
  • Ensure level

☐ Spray Lines
  • Ensure spray lines, nozzles and filters are clean
  • Calibrate herbicides, in-furrow insecticides, water and chemical rates

☐ Vacuum Pressure
  • Check all O-rings for air leakage
  • Calibrate vacuum pressure for normal and E-set planter plates
Planting Operation
Temperature Effects on Planting

THE GREEN LIGHT FOR COTTON PLANTING

Planting the cotton crop is one of the most important operations on the farm. It sets the standard for the entire season. There are some key considerations that will help ensure it’s a once only task.

Ask yourself

- Is soil temperature at 10 cm depth above 14°C at 8am AEST?
- Is forecast average temperatures for the week following planting on a rising plane?

IMPORTANT

If you cannot give a green tick next to at least one of these statements, then planting conditions are definitely unsuitable - STOP!

If you can give a green tick to only one of these statements - Be Cautious. Adjustments may need to be made.

If you can give both statements a green tick - it’s GO!

Other questions that need to be answered before planting starts

- Is the planter prepared for the coming season?
- Is the planter calibrated to the correct seeding rate?
- Is the planter adjusted for the correct planting depth?
- Have planting speed limits been set?
- Does soil tilth/condition mean other operations needed?
  eg. rolling, meshing
- Have all staff operating the planter been trained?

We know planting in cool or poor soil conditions costs time, yield and quality. Don’t get caught running the red light - it will cost you!
Soil Temperature Effects on Germination

Cotton is a temperature sensitive crop and the way the crop deals with temperature extremes is by shutting down or slowing physiological processes in the plant. Temperature experienced post-planting will also have an impact on the time taken for the plant to emerge. The slower the plant grows, the greater the chance of seedling death occurring through disease and insect damage. Figure 3:1 shows the critical times of an early seedling’s life in terms of sensitivity to temperature.

This is why it is so important to monitor soil and air temperatures to find the appropriate window to plant the crop. It has been an Australian cotton industry guideline for many years that cotton planting should not begin before soil temperatures reach 14°C or above at 10 cm depth, at 8am AEST. Planting at temperatures below this will diminish root and shoot growth, reduce water and nutrient uptake and make plants much more susceptible to attack from seedling diseases and insects. In some of the southern growing regions, it can be difficult to reach these temperatures in early October and therefore a forecast for rising temperatures, it could be very different in the time it takes for a crop to emerge and establish, depending on the temperature regime and the day degree accumulation.

This decision tool uses the accumulated day degrees over a 7-day forecast, whilst also taking into account the influence of cold shock, to give you a figure out of 100. This is then divided into four categories

<table>
<thead>
<tr>
<th>Range</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-30</td>
<td>Very poor conditions</td>
</tr>
<tr>
<td>30-50</td>
<td>Marginal conditions</td>
</tr>
<tr>
<td>50-80</td>
<td>Adequate conditions</td>
</tr>
<tr>
<td>80-100</td>
<td>Good conditions</td>
</tr>
</tbody>
</table>

Soil temperature and forecast now on CSD web site

CSD supports an expanded, real time soil temperature network spanning the entire Australian cotton industry, funded in partnership with Syngenta from the FastStart™ R&D Fund.

The CSD E&D team has developed a new tool to use when deciding if weather conditions are right for you to begin planting in your specific region. With the expansion of the industry into the south, growers are now planting in Moree and Griffith on the same day and although the forecast may be for rising temperatures, it could be very different in the time it takes for a crop to emerge and establish, depending on the temperature regime and the day degree accumulation.

This decision tool uses the accumulated day degrees over a 7-day forecast, whilst also taking into account the influence of cold shock, to give you a figure out of 100. This is then divided into four categories.
Sensitivity to Chilling

Days after planting

Radicle Growth

Dry Seed

Water Uptake

Increased Metabolism

Low

High

Figure 3.1 Cotton seed sensitivity to chilling injury through germination and establishment.

These categories are based on research that was done looking at the effect of temperature on speed of germination. CSD encourages cotton growers and consultants to use the soil temperature network along with this new planting decision tool to refine and customise their cotton planting decisions. The soil temperature network along with the new planting decision tool can be found at www.faststartcotton.com.au

Figure 3.2 (Above) Impact of soil temperature on seedling mortality. Temperature is the average minimum soil temp for the 7 days after sowing. (Nehl NSW DPI)
Temperature effects on speed of germination

Temperature plays a vital role in germination rate and cotton seedling development. Below 12°C growth is severely retarded. Enzymatic activity within the cotton plant does not function properly until temperature is above 15°C. There is a strong relationship between time of establishment and soil temperature, with the higher the temperature the faster the rate of germination and development.

In 2014, CSD conducted a laboratory study into the effect of temperature on the two different lots of Sicot 74BRF with differing germination percentages, using the parameters of germination measured as a 2mm radicle emergence at intervals between 24 and 120 hours. Results are shown in Figure 3.3 where there is significant difference between the rates of development at different temperatures regimes, but little difference between the rates of development between the two seed lots.

Summary

Temperatures during and post-planting have an impact on establishing cotton crops.

This analysis highlights the effect that poor seasonal conditions, slow growth and disease can have on crop establishment. It also shows that good plant stands can be achieved regardless of the variety if conditions are favourable.

In the past there has been an emphasis on planting early to give the crop time to compensate for early insect damage, reduced insect control problems and reduced cost blow outs associated with late crops. With Bollgard 3 and Bollgard II, these factors are less important and these benefits will continue with new technology based varieties.
FastStart™ Seed Treatments
Get a Perfect Start this Season

About 30 per cent of all cotton seedlings fail to survive due to disease and insect pressure, management practices and environmental factors. Of particular concern is the growing incidence of Black Root Rot, Fusarium Wilt and other fungal diseases.*

The best seed deserves the best protection. That’s why all CSD varieties are available with VIBRANCE® COMPLETE, the only seed treatment that provides all-in-one protection against *Pythium, Rhizoctonia*, Fusarium Wilt and Black Root Rot.

Plus, there’s your choice of CRUISER EXTREME® or CRUISER® for robust early season protection against aphids, thrips and wireworms in the convenience and flexibility of a seed treatment.

Combined, these quality treatments from Syngenta protect your seedlings from disease and insect pests from germination right through to stand establishment, allowing plants to express their full yield potential.

* Cotton pathology report, Cotton Catchment Communities CRC, 2011/2012.
VIBRANCE® COMPLETE from is a fungicide seed treatment offer jointly developed by Cotton Seed Distributors and Syngenta under the FastStart program which is sponsored by growers. Vibrance Complete offers growers a superior crop establishment solution which is supported by research, disease surveys and grower feedback. VIBRANCE® COMPLETE combines the activity of five active ingredients to provide broad spectrum disease control that ensures that the crop receives the best start, enhancing crop establishment and yield potential. Azoxystrobin, Fludioxinil, Metalaxyl-M, Sedaxane & Acibenzolar-S-methyl are the key active ingredients in Vibrance Complete that make Vibrance Complete so potent on disease.

Apart from controlling seedling diseases such as seedling damping off caused by pythium spp. and Rhizoctonia solani, VIBRANCE® COMPLETE induces the natural plant defence mechanism of cotton plants that increases the plant resistance to certain diseases such as fusarium wilt and black root rot. VIBRANCE® COMPLETE activates all treated plants in the field uniformly and becomes an important part of an integrated disease management program.

The significant benefits of VIBRANCE® COMPLETE include:

- A comprehensive disease management solution to enhance establishment.
- Improved plant stands. Comprehensive trials show a 27% increase over untreated seed and 4% increase over Dynasty Complete treated seed.
- Reduced risk of replant from uneven or inadequate plant stands.
- Faster crop emergence.
- Improved early crop development.
- Enhanced early plant vigour.
- Reduced disease incidence.
- Improved yield potential.
THE NEW BENCHMARK IN EARLY SEASON CONTROL

CRUISER EXTREME® seed treatment makes in-furrow granular insecticides obsolete. It delivers comparable control of sucking and soil-dwelling pests in the convenience and flexibility of a seed treatment. There’s no need for special equipment, calibration or refilling – and no worries about operator safety.

Key Benefits

- Robust protection against aphids, thrips and wireworms
- Comparable performance as in-furrow granular insecticides
- Convenient seed treatment
  - No extra equipment, calibration or refilling needed
  - Reduced worker exposure
- Reduced risk of replant from poor stands
- Available on all CSD varieties
GETS YOUR CROPS OUT OF THE GROUND, FASTER

CRUISER® provides long-lasting residual control of aphids, thrips and wireworms. Affected pests cease feeding almost immediately and starve to death within 24 hours. The active ingredient in CRUISER® has optimum water solubility making it ideal for rapid uptake even under dry conditions, thus making it an ideal choice for dryland cotton.

Key Benefits

- Long-lasting control of sucking and soil-dwelling pests
- Rapid uptake and systemic activity
- Forms protective ‘halo’ around the seed
- High solubility ideal for both irrigated and dryland cotton
- Available on all CSD varieties
Seedling Mortality

The term seedling mortality is used to describe the difference between the number of seeds planted per metre of row and the final stand per metre. It includes losses due to non-germination of the seed, the impact of sub-optimum environmental and seedbed factors occurring during the establishment period, physical problems such as fertiliser or herbicide burn and seedling death both pre and post-emergence due to biotic factors (disease and soil insects predominantly). In many situations, it is difficult to apportion the relative contribution of each of these components to the final result.

The level of seedling mortality varies from year to year and also on a regional basis. Figure 3.9 indicates the average level of seedling mortality over a 5-year period, across the major Australian cotton growing regions, established during industry disease surveys. Some regions remain at the lower end in most years e.g. St George, while others are generally at the top end e.g. Macquarie. There can also be significant variation in the one region in different years e.g. Downs.

It is important to factor seedling mortality into your planting rate decisions. Figure 3.9 gives a broad indication for regions, but seedling mortality will vary from field to field across a farm depending on varying conditions including field history, seedbed preparation, disease pressure, temperature, stubble level and establishment method. Seedling losses as a result of diseases and soil insects can be significantly reduced when the seed has been treated with VIBRANCE® COMPLETE and CRUISER®.

IMPORTANT CONTRIBUTORS TO SEEDLING MORTALITY

Environmental Factors

Cool soil temperatures influence the rate of root and shoot growth. Slow growth uses up seed energy reserves (the seedling relies on seed reserves until the first true leaf is functioning) and also makes the seedling more vulnerable to attack from pathogens and soil insects.

It is evident that very high soil temperatures also impact on early seedling growth and survival. Growers need to familiarise themselves with predicted soil and air temperature trends for the week(s) ahead and plant according to the ‘green light’ recommendations, as seen in the section ‘Temperature effects on planting’.

Figure 3.9 Disease Surveys Results 2009-2014.
**Seed bed Factors**

Poor soil tilth, evidenced in cloddy unconsolidated beds containing incorporated undecomposed trash, mainly impacts on moisture movement to the seed. Soil water in the planting zone can disappear quickly when pre-watered or watered up and soil contact with individual seeds for water transfer will be poor. The solution lies in early bed preparation and extra passes at the ideal moisture content. Poorly consolidated beds can result in the seed being more prone to sinking when watered up, impacting on plant establishment due to issues related to excessive seed depth.

Stubble, especially large undecomposed pieces mixed in the bed or ending up in the planting trench, affects seed soil contact and hence moisture uptake and makes the seedling more vulnerable to disease. The problem is lessened by smashing up stubble effectively and incorporating it early.

Lack of oxygen, most commonly occurring when rain happens within a couple of days of watering up, or a continuous spell of rain on soil close to field capacity, can cause a high level of mortality on germinating seed. Close monitoring of rain forecasts and even adjusting depth of sowing can lessen the likelihood of this damage.

Certain soils, due to their inherent sand/silt ratio are very prone to crusting, after even minor rainfall events. The inability of the seedling to push through the crust exhausts its energy reserves and makes it vulnerable to soil pathogen and insect attack.

Remnant levels of residual herbicides from previous cropping or fallow weed control applications can be taken up by young roots, slowing seedling growth, with all the consequent problems, or even killing seedlings. The same scenario can be caused by nitrogen fertiliser which due to its placement or timing has produced high levels of ammonia in the seedling root zone, burning the root tissue.

**Biotic Agents**

A range of soil fungi exist in the soil, ready to attack young cotton seedlings. The main soil-borne pathogens found across cotton growing regions are:

- **Pythium** spp.: usually cause soft rot and stem collapse, leading to seedling death.

- **Black root rot**: This disease generally causes destruction of the outer layer of the root, leading to blackening of the root structure. It results in poor, stunted growth and also weakens the seedling exposing it to attack from other pathogens such as *Pythium* and *Rhizoctonia*.

- **Rhizoctonia** sp: Cause sunken red/brown lesions on the lower stem and roots leading to poor/stunted seedling development.

The survival and development of most of these pathogens is favoured by cool, wet soil conditions. Avoiding planting into conditions that favour these seedling diseases will give you a greater chance of getting a better, stronger establishment. For more information on these and many more seedling diseases go to: [http://www.cottoninfo.com.au/disease-management](http://www.cottoninfo.com.au/disease-management)
Planting Population and Seeding Rate
Planting Population and Seeding Rate

YIELD NEEDS TO BE MAXIMISED PER PLANT PER HECTARE

When deciding upon the ideal plant population, many factors need to be considered. As a grower you need to consider:

- Soil type and condition
- Irrigated or dryland production system
- Soil water holding capacity - planting moisture, watering up or pre-irrigating
- Long term average yields - based on area with plant population rates
- Germination rates
- Seedling mortality - disease and insects
- Rainfall and temperature (soil temp and forecast air temperature)
- Row spacing

CSD recommends 10 plants/m established for irrigated conditions north of Dubbo and 12 plants/m established south of Dubbo, while for dryland conditions 6 to 8 plants/m established.

Ingard and Bollgard II

The introduction of Ingard and especially Bollgard II™ varieties alerted agronomists to a noticeable change in some plant growth characteristics, due to significantly less tipping out and also much higher levels of early fruit retention. Since 1999, CSD has carried out numerous plant stand trials, both in irrigated and dryland fields. We assessed yield, fibre quality and plant growth differences across a wide range of plant stands. Most of these have been small plot replicated trials, harvested with single row plot pickers and treatment samples ginned through research gins for turnout per cent and fibre quality analysis. The assistance of the CSIRO cotton plant breeding team in harvesting many of these trials and Dr Warwick Stiller’s analysis of the data is gratefully acknowledged.

Plant stand recommendations for conventional varieties

Many industry trials on conventional cotton varieties were conducted between 1975 and 1995 to look at the optimum plant stand for maximising yield. Overall findings were that growers should aim to have 8 to 10 established plants per metre.

![Figure 4.0](faststartcotton.com.au)

Summary of CSD plant population trials from the past 9 seasons.
(Irrigated 21 trials, and Dryland 9 trials)
The yield trend has been reasonably similar across most of these trials, despite them being grown across a wide spread of locations, experiencing varying seasonal conditions and using a range of cotton varieties.

In irrigated fields, plant stands of 4 to 5 plants/m and less have consistently produced lower yields. In almost all of the 23 irrigated trials, the highest yield has come from a stand somewhere in the 10 to 15 plants/m range. The yield response illustrated in Figure 4.0 shows the relative yield across the population range after combining the data from all these trials.

To improve the relationship, the data has been grouped into ranges of stands rather than individual stands, which results in more trials contributing to each point on the graph. An important finding from this work is that there has been no indication of a yield penalty associated with higher stands i.e. up to 15 plants/m.

This difference from plant stand response with conventional varieties could relate to higher earlier fruit retention having an effect on root development. Alternatively, the different plant structure with most mature bolls concentrated on the plant main stem and much less on vegetative branches initiating from tipping out may be a factor.

While fewer trials have been conducted in dryland situations the same general yield response is evident, although the data does fluctuate more due to the greater extremes dryland crops experience. In most trials, the best dryland yields have come from plant stands of 6 to 10 plants/m, regardless of row configuration. Lower stands of 3 to 5 plants/m and higher plant stands greater than 12 plants/m are penalised for yield in most situations due to poor plant stand uniformity or competition.

A cotton plant will compensate for any gaps in the plant stand by using its ability to produce more fruiting sites along the fruiting branch. This ability will help to increase yield under a ‘gappy’ plant stand. However, it will delay maturity which will influence micronaire and can also delay harvest.

**Figure 4.1** Yield per hectare and yield per plant is optimised at around 10 plants per square metre.
CSD has conducted numerous trials over a number of years to look at the plants’ ability to compensate for row gaps and see what the ideal plant populations are, relative to circumstances. Current recommendations are:

- **Approximately 10 plants/m established is ideal for warm growing areas (north of Dubbo).**
- **Approximately 12 plants/m established is ideal for cooler growing areas (south of Dubbo).** This is due to the fruiting positions being set closer to the main stem with very few 3rd and 4th positions, which can take longer to mature and can cause significant issues associated with lower micronaire.

Low plant population can result in issues when something goes wrong. Populations that have skips or gaps, with greater than two 50 cm gaps in 5 metres can have reduced yield potential, as plants struggle to compensate for these gaps. The same can be said for double-ups with 2 seeds being planted on top of each other. Both seedlings compete against each other for resources and usually neither plant succeeds in reaching full potential. It is important that plant stand is uniform. Adjust seeding rates to compensate for equipment, time of planting (temperature) and soil conditions. Crop establishment is the most critical phase for achieving the highest yield. Poor preparation will lead to setbacks, which is difficult and expensive to recover from e.g. replanting in Murrumbidgee can reduce yields by up to 2 b/ha.

### ROW SPACING

Generally, we see cotton grown on variants of 1 metre (40 inch) row spacings. In southern growing areas, row spacing is often narrowed down to 91 cm (36 inch) and even to 76 cm (30 inch). These row spacings have been inherited from corn and vegetable programs.

Wider row spacings such as 1.5 m (60 inch), 2 m (80 inch) and double skip (2 rows in 2 rows out) are often used in dryland situations or where water is limited. The aim of the wider row spacing is to maximise the water use efficiency of the crop.

#### Table 4.0 Plants per metre of row, plants per hectare.

<table>
<thead>
<tr>
<th>Plants/m</th>
<th>30 inch (75 cm)</th>
<th>40 inch (1 m)</th>
<th>60 inch (1.5 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>133,333</td>
<td>100,000</td>
<td>66,660</td>
</tr>
<tr>
<td>12</td>
<td>160,000</td>
<td>120,000</td>
<td>79,992</td>
</tr>
<tr>
<td>14</td>
<td>186,667</td>
<td>140,000</td>
<td>93,324</td>
</tr>
<tr>
<td>16</td>
<td>213,333</td>
<td>160,000</td>
<td>106,666</td>
</tr>
<tr>
<td>18</td>
<td>239,999</td>
<td>180,000</td>
<td>119,988</td>
</tr>
</tbody>
</table>

**faststartcotton.com.au**

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[FastStart Cotton](http://faststartcotton.com.au)
Plant establishment survival (mortality percentage) will vary from region to region and can vary from field to field, based on differences in soil types/conditions.

**REPLANT**

The decision as to replant or not is sometimes a straightforward one and other times not. The obvious question is, will I achieve better results with the plants I’ve got or should I start again?

It is desirable to have 8 to 10 plants (10 to 12 plants in cooler areas) per meter of row, distributed along the row as uniformly as possible. Potential yield declines as planting is delayed (refer to Figure 4.5).

An inadequate plant stand generally results in a decline in yield and also a decline in maturity of the crop. Cotton plants will compensate for gaps in the crops, but the delay in maturity will start to become an issue as these plants around the gaps take longer to mature, compared to those with a uniform plant stand. This is particularly important in southern growing regions.

<table>
<thead>
<tr>
<th>Example</th>
<th>Poor soil conditions represent cool air temperatures for the week after planting, usually back to back with a Field Score of 3 to 5 and a low soil temperature (&lt;14°C).</th>
<th>Good soil conditions represent rising warm air temperature post sowing, usually a fallow field with a Field Score of 2 or above and a warm soil temperature (&gt;16°C).</th>
</tr>
</thead>
</table>
| Desired plant stand | • 10 plants/m  
• 100,000 plants/ha | • 10 plants/m  
• 100,000 plants/ha |
| Divide by estimate plant survival | • 60%  
(40% establishment mortality)  
• 100,000 / 0.60  
= 166,666 | • 80%  
(20% establishment mortality)  
• 100,000 / 0.80  
= 125,000 |
| Divide by the germination percentage of your seed | • 89%  
166,666 / 0.89  
= 187,265 | • 89%  
142,857 / 0.89  
= 144,044 |
| Your seeding rate | • 187,265 seeds/ha  
18.7 seeds/m | • 144,044 seeds/ha  
14.0 seeds/m |
| Divide by seeds/kg for your variety | • 11,500 seeds/kg | • 11,500 seeds/kg |
| kg/ha required | • 187,265 / 11,500  
= 16.3 kg/ha | • 144,044/11,500  
= 12.5 kg/ha |

**Table 4.1** Examples of planting rate calculation.
Factors to consider with replanting

Things you need to consider before replanting are what caused the low plant stand. Was it insects, disease, hail damage, herbicide or fertiliser damage, planting depth, seed bounce or a watering issue? You will need to be confident you can overcome these issues before you replant, or they will likely happen again. Before you start, consider

- Replanting date. Be aware of when yield potential will start to decline. Consider the micronaire period, especially in the cooler areas. Not only will yield decline but you may not be able to mature up the fibre.
- Insects. Will damage by wireworms, thrips, or other pests reduce the stand further?
- Weeds. Will a low population or ‘gappy’ plant stand, encourage a weed problem?
- Disease. Will Rhizoctonia, Pythium or Black Root Rot reduce the stand further and are the current seedlings still being affected by disease?
- Hail damage. Will the seedling regrow?
- Herbicide damage. Has rain washed residual herbicides into the root zone?
- Water. Will a flush help to wet the bed to germinate dry seeds or waterlog the seedlings?
- Temperature. What is the outlook. Is the soil temperature above 14°C and do you have a rising temperature ahead (refer to traffic light for planting temperature)?

Figure 4.4 demonstrates the relative yield potential 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 to 10 plants/m of row has the best yield potential. A variable stand will reduce yield for all plant populations.

Figure 4.4 Relative yield potential at a range of plant stand uniformities (Constable 1997)
Planting date will have different yield potential for a range of growing regions. Figure 4.6 shows that sowing to mid-October has the best yield potential for most locations. For cooler locations, yield potential will decline more rapidly for later sowings than in warmer locations (narrow planting window). In some situations, it might be better to run with the stand you have because replanting may not achieve the desired yield due to season length and could cause issues related to maturing cotton fibres and low micronaire.
COTTON PLANTING RATE CALCULATOR
The cotton planting rate calculator can be a helpful tool in determining the planting rate required in order to achieve a desired plant stand. There are a number of factors that need to be considered in order to determine this, namely
• Variety
• Field conditions
• Disease levels of planting region and individual fields
• Establishment method
• Seed germination percentage
• Soil temperature at planting
• The 7-day forecast
It is important to note that all of these factors will influence the calculated seeding rate required to achieve an adequate plant stand. Therefore, it is important that each field is treated as a separate operation and the calculator be used as a tool in the decision making process.

REPLANT DECISIONS
There are a number of things that will influence the decision to replant. The main factors are:
• **Plant population.** You should consider the plant stand that was originally planned and compare this to the established population. It is important to look at this across a whole field level. Replanting certain areas of a field can impact on crop management later in the season, such as irrigation and plant management with plants at different growth stages e.g. Pix, shielded herbicides. Cotton crops are able to compensate reasonably well, provided plant stands are uniform and any gaps are consistent.
• **Uniformity of plant stand.** If the plant stand has numerous gaps that are at least 65cm in length, replanting may be considered. Potential yield loss may be less if ‘gappy’ rows are beside rows with adequate plant stands, as these more uniform rows may utilise resources from the gaps.
• **Growing conditions.** Crop health and growing conditions will also play a part in the decision to replant. It is important to consider whether the plants remaining in the stand are healthy and will survive, if only sections of a field are to be replanted.
## COMPARING THE EXTREMES OF LOW AND HIGH PLANT POPULATION ON COTTON PLANT GROWTH AND MANAGEMENT

<table>
<thead>
<tr>
<th>Low plant population</th>
<th>High plant population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants will have a much wider spread as they grow into the gaps</td>
<td>Plants will be taller, although more compact and with a more even fruit distribution</td>
</tr>
<tr>
<td>Plants may fruit earlier, but be later in maturing</td>
<td>Plants will put on more vegetative nodes, delaying fruiting</td>
</tr>
<tr>
<td>More fruit concentrated on vegetative branches and closer to ground level</td>
<td>More fruit concentrated on the main stem of fruiting branches</td>
</tr>
<tr>
<td>Plant cut out will be delayed</td>
<td>Plants will cut out earlier</td>
</tr>
<tr>
<td>Decrease in picking efficiency</td>
<td>Increase in picking efficiency</td>
</tr>
<tr>
<td>More difficult to control plants in post-harvest operations e.g. root cutting</td>
<td>Easier to control plants for post-harvest removal</td>
</tr>
</tbody>
</table>

Planting

Although cotton does have an ability to compensate for gaps or unevenness of plant stand, it is critical to achieve plant stand uniformity to assist crop management through the season. Precision planters allow for even seed spacing and a uniform seed depth. Press wheels enable good seed soil contact to be achieved and there is also the opportunity to additionally apply starter fertiliser, insecticides or fungicides through various attachments.

The aim for every cotton grower should be to plant the crop once, achieve the desired plant stand and evenness and get the crop off to a great start. Many components contribute to a successful planting operation, each contributing to crop establishment and ultimately impact the performance of the cotton crop through the entire season.

Figure 4.7 Ideal seed placement, uniformly spaced and at a uniform depth.
PLANTER SPEED

One of the keys to plant stand uniformity is planter speed. The aim should be to plant with precision, not speed.

Cotton planter speed trials were conducted to look at the effect on establishment using commercial planters at varying speeds. Sites varied in soil type, moisture, rotations, disease and insect pressure and weather conditions and were located from Emerald to Griffith. The only variable in each trial was speed. That way, speed of planting was the only contributing factor to any difference in establishment at each trial site.

Each area had its own different seed drop (seed planting rate). The data collected can be seen in Figure 4.8 and represents the percentage loss from the initial seed drop. For example, if the treatment was planted at 10 seeds/m and only 5 plants established for 10 km/h, this would represent 50 per cent establishment for 10 km/h.

The data shows there is an ideal plant speed around 8 to 10 km/h. The average population decreased when the planter sped up past 10 km/h, while the percentage increased from 4 km/h to 8 km/h.

Figure 4.8 Effect of planting speed on establishment percentage.
PLANTING DEPTH

The depth you want your seed depends on the method of establishment and soil conditions. Many people use the ‘knuckle’ as a quick and easy measurement tool in the field (Figure 4.9). When planting into moisture, some dry soil above the seed slot is useful to prevent moisture loss from around the seed. If there is too much however, a rainfall event after planting will turn this dry soil into wet soil and increase the difficulty for young seedlings pushing through. Check the consistency of the soil above the seed. If the pressure from the press wheels on the planter is set too high, you can get a compacted zone above the seed and the young seedling will have a tough time emerging.

A trial conducted in Wee Waa in 2014/15 showed the effects of different planting depths on final establishment. The trial field was ranked with a CSD Field Condition Score of 5 and was watered up. As shown in Figure 5.1, as expected, deeper planting depths had lower establishment. The ideal depth in this situation was between 2 and 4 cm (0.75 to 1.5 inches). The lowest establishment was recorded in the shallowest planting and the amount of blue capping was noticeably higher in the shallower treatment (soil friction is required to remove the seed cap).

A study undertaken in 2014 by CSD was conducted in a controlled temperature environment where Sicot 74BRF was subjected to 2 regimes, a 30/20°C cyclic and 18°C constant temperature. Superimposed on these temperatures were different planting depths in sand filled growth pots varying from 2 to 8 cm in depth.

The results are shown in Figure 5.2 from which we can deduce some important points.

- Higher temperatures resulted in significantly improved cotton establishment.
- At a depth of greater than 5 cm establishment was compromised, even under ideal conditions. This was exacerbated at cooler temperatures.
- It took 13 days for the 2 cm depth treatment at 18°C to establish 60 per cent of seeds.
- It was possible to compensate for deeper planting at higher temperatures.

There will be continued work looking at planting depth this coming season, inside controlled environments and in field trials.
<table>
<thead>
<tr>
<th>Establishment method</th>
<th>Ideal depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting into moisture (rain or pre-irrigated)</td>
<td>2.5 and 4.5 cm (1 to 1.5 knuckles)</td>
</tr>
<tr>
<td>Planting dry and watering up</td>
<td>2.5 cm (1 knuckle)</td>
</tr>
</tbody>
</table>

**Table 5.0** (Left) Generic recommendation for planting depth based on establishment method.

**Figure 5.1** Effect of varying planting depths on final establishment. (CSD Trial, Wee Waa 2014)

**Figure 5.2** (Bottom Right) Interaction between planting depth and temperature on cotton establishment.
Seed lubricant

Planter manufacturers all recommend the use of talcum powder or graphite for good reason. The use of lubricant improves seed flow and uniformity and also reduces wear rates on plates and boxes. This is the case in both brush type and vacuum planters.

In both laboratory and field tests carried out by CSD, there has been an improvement in seed drop and uniformity. In a bench test with a John Deere MaxEmerge™, the addition of lubricant improved seed uniformity by 7 per cent (see Table 5.1). A trial was conducted under field conditions examining standard John Deere plate, e-sets and hill drop seed plates. Across all planter plate types within the trial, there was an improvement in plant establishment with the use of lubricant.

<table>
<thead>
<tr>
<th>No Lubricant</th>
<th>Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniformity</td>
<td>85%</td>
</tr>
</tbody>
</table>

Table 5.1 Ute top analysis of the benefits of seed drop uniformity through the use of seed lubricant.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Plants/m</th>
<th>Average Gap</th>
<th>St. Dev. Average Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Lubricant</td>
<td>11.84</td>
<td>8.48</td>
<td>6.31</td>
</tr>
<tr>
<td>Lubricant</td>
<td>13.00</td>
<td>7.71</td>
<td>4.29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E-Sets</th>
<th>Plants/m</th>
<th>Average Gap</th>
<th>St. Dev. Average Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Lubricant</td>
<td>8.78</td>
<td>11.43</td>
<td>6.31</td>
</tr>
<tr>
<td>Lubricant</td>
<td>11.34</td>
<td>8.95</td>
<td>5.51</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hill Drop</th>
<th>Plants/m</th>
<th>Average Gap</th>
<th>St. Dev. Average Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Lubricant</td>
<td>6.72</td>
<td>15.08</td>
<td>13.31</td>
</tr>
<tr>
<td>Lubricant</td>
<td>6.90</td>
<td>14.53</td>
<td>13.50</td>
</tr>
</tbody>
</table>

Table 5.2 Effect of the addition of lubricant in the establishment rate and uniformity of planting across three planter plate types.
Establishment Method
Establishment Method

The method of plant establishment is influenced by numerous factors. Some of these are mentioned below:

- Has rain fallen in the previous two weeks and is this enough moisture to plant on?
- How much water is available for the season and is there enough to pre-irrigate or water up?
- What sort of soil conditions exist? For example, a rough seedbed with large aggregates may need pre-irrigation to break the soil structure down.
- Is flushing up going to cool the soil and impact on plant establishment?

All these questions are relevant and will influence a grower’s decision in terms of establishment method.

There are issues associated with all establishment methods and each individual field and property will have certain restrictions on how they irrigate. The advantages and disadvantages can be seen in Table 5.3. Each field and property will have certain restrictions on how they operate, e.g. ordering water that takes 3 weeks to get to the farm gate can determine when planting will begin. In both the pre-irrigated and rainfall establishment instances, the main concern is uniformity of moisture. If in doubt, lifting the planting rate will compensate for this to create a more uniform plant stand.

PLANTING DRY AND WATERING UP

This method has advantages in hot climates, because it cools the soil and crop establishment is rapid. When planting dry, it’s very important to be aware of the consistency of the seed bed. A poorly consolidated (or cloddy) hill can collapse when the water hits it and can drop the seed down to greater depths, resulting in poor or variable establishment. This is especially important for crops coming out of corn or sorghum.

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

PRE-IRRIGATION

Consider pre-irrigating when:

- There is a large seed bank of difficult to control weeds and the soil is very dry and temperatures are high.
- Planting any shallower than 2.5 cm doesn’t allow the plant the chance to scrape off the seed coat at germination and the growth of that plant will be quite slow until the coat is thrown off.
- If the beds are too wet at planting, you end up with a shiny, smeared planter 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.
PLANTING ON RAIN MOISTURE

Although this is what dryland growers do every year, many irrigators also aim to establish their crop on rain moisture to save water on pre-irrigation or watering up. There are a number of factors that will improve the likelihood of success with planting into rain moisture and some cautionary points for those attempting it on irrigated country.

STUBBLE

The presence of standing stubble will increase the chance of seedling survival in moisture planting situations dramatically, because it increases the amount of infiltration and hence moisture available to the seedling. It also reduces surface evaporation and protects the young seedling from the elements. But be aware of too much stubble that can have a negative impact at planting time with stubble causing hair-pinning and blocking of planter discs.

BARE FALLOWS IN IRRIGATION COUNTRY

A bare fallow can be a risky practice and often results in replanting if conditions are not ideal. Fields hilled for irrigation are designed to shed water so you need to check whether moisture has infiltrated to any depth into the seed zone. In cloddy seedbeds the fine materials may be wet but the larger clods may be dry and may draw moisture away, drying the seed bed.

Check across a field to see whether the rainfall has been uniform. When planting, check soil moisture levels in the seed zone regularly. Planting depth may need to be adjusted throughout the planting operation due to movements in seed zone moisture.

In furrowed fields, rainfall will usually not fill the soil profile as well as irrigation, so after emergence soil moisture levels and the vigour of the young seedlings need to be monitored closely. In worst case scenarios an early first irrigation may be required.

In conventional 1 metre hills the fallow rainfall sheds from the top of the hill to the furrow and out of the field.
<table>
<thead>
<tr>
<th>Pre-irrigation (prior to planting)</th>
<th>Watering-up (after planting)</th>
<th>Pre-irrigation and late watering up</th>
<th>Establishing on rainfall moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Likely advantages</strong></td>
<td><strong>Likely advantages</strong></td>
<td><strong>Likely advantages</strong></td>
<td><strong>Likely advantages</strong></td>
</tr>
<tr>
<td>a. No time pressure to apply water</td>
<td>a. Potential to take advantage from pre-planting rain event</td>
<td>a. Helps in fixing plant stand problems</td>
<td>a. Significant saving in use of irrigation water reserves</td>
</tr>
<tr>
<td>b. In heavy clay soils, water losses can be less than keeping it in farm</td>
<td>b. Easier to plant, especially when beds are not 100% even</td>
<td>b. Can give the crop the necessary ‘boost’ to get going after a slow start</td>
<td></td>
</tr>
<tr>
<td>c. In cooler areas, allows the soil temperature to increase to eliminate cooler conditions from the watering up irrigation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Likely disadvantages</strong></td>
<td><strong>Likely disadvantages</strong></td>
<td><strong>Likely disadvantages</strong></td>
<td><strong>Likely disadvantages</strong></td>
</tr>
<tr>
<td>a. Soil drying out too quickly</td>
<td>a. Higher disease pressure</td>
<td>a. Likely to use more water</td>
<td>a. Non uniform moisture distribution in the seed zone across entire paddock and soil types</td>
</tr>
<tr>
<td>b. Dry rows in uneven fields</td>
<td>b. Herbicide damage more likely</td>
<td>b. Similar disadvantages to watering up</td>
<td></td>
</tr>
<tr>
<td>c. Soils stay too wet when followed by rain</td>
<td>c. Sides of beds might erode while flushing for a long time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Unable to catch rainfall before planting</td>
<td>d. Water logging if rainfall occurs after flushing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Planting soil temperature difficult to forecast</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.3 Advantages and disadvantages of different options for the first irrigation. Adapted from S Henggler, Waterpak
Low Density Seed Considerations

There is variation in seedling vigour across all cotton varieties. This relates to the composition of the seed and its interaction with environmental factors. One group of current varieties, which includes Sicot 746B3F, Sicot 748B3F, Sicot 754B3F, Sicot 730 and Sicot 75RRF, displays higher than average lint turnout, basically because more resources are put into lint and less into seed during late growth. The seed produced generally has lower density (lighter) and may have a lower oil content and smaller size than other varieties and hence is more difficult to establish under less than ideal conditions. Use of low seed density varieties calls for extra care and attention to detail with both land preparation and in the planting operation to ensure an adequate establishment is achieved.

Direct comparisons of these varieties from the CSD variety trial program between 2011 and 2015 has shown that on average there is an 11 per cent higher plant stand in Sicot 71BRF versus Sicot 74BRF. This data is significant because it comes from replicated trials, with the planter and planting conditions exactly the same for each variety. However, further investigation of this data set shows there is an even greater yield improvement by Sicot 74BRF when the plant stand is close to or equal to Sicot 71BRF. This is only a minor relationship, but takes the total percentage increase from 3.2 per cent to 4.5 per cent or 0.33 to 0.47 b/ha as shown in Figure 5.3.

PLANTING CONDITIONS AFFECT ON LOW DENSITY VARIETIES

Low density seed has less stored energy which means when conditions are less than ideal, those varieties have lower seedling vigour and establishment.

In good conditions, low density varieties are able to record establishment rates similar to normal density varieties. Lower establishment counts have been recorded where planting conditions were less than ideal (cloddy, cool, stubble). In the 2014/15 cotton season the CSD Ambassador network looked at the effect of field conditions on the establishment of Sicot 74BRF. Fields were ranked based on the CSD Field Conditions Score, which takes into account clod shape and size, bed consolidation and trash type and level. Figure 5.4 shows the final establishment results of the 42 ambassador sites. There is a clear trend that as planting conditions became rougher the final establishment decreased.

It should be noted that there is a lot of spread in the data which is a result of differences in planting temperatures, field preparation and establishment method.
Soil temperature at planting and the following air temperature regime played an important role in cotton establishment. Trials planted later in the planting window when soil temperatures were higher showed an improvement in the ratio of establishment of Sicot 74BRF to Sicot 71BRF (Fig 5.5). Analysis was conducted examining the influence of back-to-back and fallow conditions and establishment method impacting varietal stand in the CSD variety trials. There was no difference in the ratio of establishment between Sicot 74BRF and Sicot 71BRF due to field preparation. For both varieties it was lower in back-to-back situations than in fallow (Fig 5.6). Pre-irrigation resulted in a marginally closer relationship between the 2 varieties than either watering up or planting on rain moisture (Fig 5.7).

This analysis highlights that differing conditions will impact on establishment of low seed density varieties in different ways. It is important to understand this and adjust planting rates accordingly to compensate.
PLANTING RATE CASE STUDY

CSD has conducted field experiments over the past 5 seasons to evaluate this management technique. Within this study, Sicot 71BRF and 74BRF were planted at the co-operator’s normal planting rate, with an additional planting of Sicot 74BRF included where the planting rate was adjusted by moving the planter sprocket 1 ratio higher resulting in a similar established plant population of Sicot 74BRF to Sicot 71BRF.

We were able to generate a yield increase of Sicot 74BRF over Sicot 71BRF through this simple procedure of adjusting the planting rate. Conservatively, this translates to a $45/ha return for around $14/ha in additional planting seed costs per hectare. Summed over every hectare planted, this is a considerable improvement to the bottom line of the cotton farming operation for a simple adjustment.

As an agronomic and a risk management tool, it makes sense to increase the planting rate of Sicot 74BRF to maximise the chance of getting the desired plant stand. The same principle applies with other low seed density varieties such as Sicot 75BRF, Sicot 75RRF and Sicala 340BRF.

<table>
<thead>
<tr>
<th>Sicot 71BRF</th>
<th>Sicot 74BRF</th>
<th>Sicot 74BRF (adj.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants/m</td>
<td>9.9</td>
<td>9.3</td>
</tr>
<tr>
<td>Yield (b/ha)</td>
<td>10.9</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Table 5.4 Planting rate adjustment trials (2 year average)
Till Flowering
Importance of Weed Control

“Don’t let weeds determine your yield - get them early, get them all”

Weeds in cotton crops rob the plants of water, nutrients and sunlight and can contaminate the picking operation and degrade fibre quality.

Take an aggressive stance on weeds and volunteer cotton from an early stage. Research has shown that if left uncontrolled up to first flower, just 4 weeds per m² germinating with the crop can reduce final yield by 45 per cent (G. Charles, ACRI Narrabri).

Volunteer cotton is also a weed that will remove valuable nutrients and water from the crop, reduce yield and can also cause significant issues at picking with plants that are adjacent to the planting row. Picker blockages will cause poor picker efficiency. Volunteer plants and weeds also host insect pests and diseases. Insect numbers can start to build up early in fields, giving the insects a head start and causing earlier spraying than usual.

There are number of ways of controlling both weeds and volunteer cotton

- Pre-irrigation is still the best way to gain control by germinating volunteers and weeds in spring ahead of planting and then removing them before crop emergence.
- Once they emerge in the crop they are more difficult to control, but the key remains to control them early with a herbicide or cultivation.
- Pre-emergent residual and lay-by herbicides have become cheaper over the last decade and they are a good tool to support glyphosate sustainability.
- The keys to successfully keeping weeds and volunteer cotton under control are to use all the tools available. Do not rely on just one tactic alone!

Volunteer cotton in a recently planted field (where are the planting rows?).
### The Critical Period for Weed Control

Adapted from “Using the critical period for weed control in Roundup Ready Flex™ Cotton”, Charles, Taylor, Farrell, NSW DPI.

<table>
<thead>
<tr>
<th>Weed Density (weed/m row)</th>
<th>Critical Period (Day Degrees)</th>
<th></th>
<th>1% threshold (High Yield Potential - Irrigated)</th>
<th></th>
<th>3% threshold (Lower Yield Potential - Dryland)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Start</td>
<td></td>
<td>Start</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>End</td>
<td></td>
<td>End</td>
<td></td>
</tr>
<tr>
<td><strong>Medium Broadleaf Weeds</strong></td>
<td></td>
<td></td>
<td>Start</td>
<td></td>
<td>Start</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>End</td>
<td></td>
<td>End</td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>111</td>
<td>210</td>
<td>-</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td>111</td>
<td>310</td>
<td>178</td>
<td>222</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>110</td>
<td>507</td>
<td>177</td>
<td>368</td>
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<tr>
<td>1</td>
<td>110</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>109</td>
<td>827</td>
<td>170</td>
<td>653</td>
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<td></td>
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<tr>
<td>5</td>
<td>105</td>
<td>959</td>
<td>158</td>
<td>798</td>
<td></td>
<td></td>
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<tr>
<td><strong>Large Broadleaf Weeds</strong></td>
<td></td>
<td></td>
<td>Start</td>
<td></td>
<td>Start</td>
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<tr>
<td></td>
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<td>959</td>
<td>158</td>
<td>798</td>
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<td></td>
</tr>
<tr>
<td><strong>Grass Weeds</strong></td>
<td></td>
<td></td>
<td>Start</td>
<td></td>
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<tr>
<td></td>
<td></td>
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<td>50</td>
<td>115</td>
<td>600</td>
<td>124</td>
<td>477</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7.1 The critical period for weed control.
Early in the cotton growing season there is a critical time where weeds, if controlled when they are small, will not impact on crop yield potential.

The critical period is defined by the type and density of weeds, potential crop yields, the cost of weed control and the economic threshold the grower chooses. The critical period is defined in Table 7.1 for large and medium sized broadleaf and grass weeds in high yielding irrigated cotton, and lower yielding or dryland crops.

This method focuses on the management of Roundup Ready Flex® cotton crops because it is the most common grown in Australia, but is readily adapted to conventional crops as well.

**What constitutes a large, medium broadleaf or grass weed?**

- Large broadleaf weeds - weeds which are larger than the cotton plant at maturity
  - Noogoora burr group
  - Thornapples
  - Sesbania and budda pea
- Medium broadleaf weeds
  - All other weeds can be included in this group, including volunteer cotton.
- Grasses
  - Includes the grasses and other grass like species, such as nutgrass

Roundup Ready Flex® Technology offers flexibility in control of weed infestations quickly without injuring the young cotton crop.
Early Season Insect Pests

A number of insects are active feeders on young cotton plants attacking leaves, growing tips and squares. Because of the complexity of relationships between various insect groups (pest and predator), a certain level of damage can be tolerated without concern about yield loss or crop delay. Longer growing season areas, where there are more day degrees available for the crop to grow and compensate, can tolerate higher levels of damage than short season areas. Monitoring of damage and an understanding of the individual pest dynamics (i.e. ratio of adults to nymphs/larvae) is important in formulating control decisions and also what products to use. Insects from 4 key groups are frequently present in the early growth stages of the crop.

THRIPS

Thrips coming from neighbouring maturing cereal crops generally only cause distortion and cupping of young leaves. This is generally only cosmetic and has little influence on final yield and maturity. Very heavy populations (more than 30/plant) can cause maturity delays of up to 7 days due to a reduction in leaf biomass and tipping out. Research conducted by Dr Lewis Wilson (CSIRO) has shown that thrip damage was responsible for yield and maturity damage 1 in 10 years in hot and central regions. In the upper Namoi and the Macquarie River Valley thrip had an impact 1 in 3 years.

Cool weather can exacerbate the damage while warm conditions will help the plants grow away. Under cool conditions thrip damage can cause boll maturity to be delayed as a result of tipping out and having the plant compensate for the damage. In southern NSW this can impact on yield and fibre quality due to the shorter growing window and the bolls failing to mature (not enough day degrees to make up for the loss).

Thrips are an important predator of spider mite. Hence use of insecticides for their control can increase the risk of a mite outbreak later in the season. Seed applied insecticides or in-furrow applications generally provide good suppression of moderate thrip populations for approximately 30 days post-planting.

Image: Cotton CRC.

faststartcotton.com.au
MIRIDS

Mirids can make their presence felt early in the season due to terminal feeding and blackening and square loss. Populations vary enormously between seasons. They are a very mobile pest with populations fluctuating rapidly, so sampling needs to occur at least at 3 day intervals. Using beat sheets picks up adults, nymphs and blackened squares. It is possible to avoid treatment if the crop can approach first flower with retention remaining above about 65 per cent. The concern with treatment is that most insecticides will have an impact on predators, causing flaring of possible background pests such as aphids and silver leaf whitefly.

TIPWORM

The presence of tipworm (*Crocidosema plebejana*) is strongly related to the presence of marshmallow weed, which is more abundant if there has been a wet winter and cool conditions continue into spring. Cotton is a host of this pest until flowering commences, when tannin levels make it unattractive. Tipworm appear not to have strong dispersive capacity, so local weed levels will strongly influence infestation levels. While Bollgard II controls the pest, heavy populations can still result in a significant level of damage.

APHIDS

While normally considered a pest of mature cotton, where honeydew contamination of lint becomes the principal reason for control, early season aphids can be a concern because of their role as a possible vector of the virus causing cotton bunchy top. Because of their potential to develop resistance to some insecticides, early spraying should only be undertaken as a last resort.

Refer to cotton pest management guide for further reference.
Moisture Status at First Flower (First Irrigation)

Soil moisture availability in the lead up to first flower plays an integral role in ensuring the crop enters the flowering period growing well. The timing of the first irrigation is dependent on many variables, such as soil water holding capacity, temperature, rainfall and crop developmental stage.

Water usage of the crop increases in the lead up to flowering and rapidly increases up until peak flowering. Therefore, in many situations the first irrigation plays an important role in setting up the plant for future growth and fruit retention, fibre quality and boll weight. The first irrigation timing is perhaps the most difficult irrigation decision. It is a balancing act between ensuring stored water in the soil profile is fully explored by the developing root system, while not stressing the plant and hindering both vegetative and reproductive development.

Irrigating late will reduce yield potential due to the impact of water stress on plant development. It is difficult to recover the growth needed for supporting fruit growth if water stress has slowed growth. Irrigating too early can predispose the crop to excess vegetative growth and limit root exploration into the soil profile, which can affect the subsequent irrigations. It is important to monitor your crop growth, development, vigour, soil moisture status and root expansion and extraction patterns as well as crop daily water use.

• As a rule of thumb
  - Irrigate at 50-60 per cent available soil water within the root zone.
  - Traditionally in Australian conditions first irrigation occurs between 45-60 days after planting.

• It is important to
  - Check weather forecasts as this will allow for fine tuning of the irrigation decision.
  - Monitor crop node development post squaring for signs of slowing growth.

• Use of water tools
  - C-probes, Capacitance probes and IR sensors can be useful in understanding water dynamics in the soil.
  - More information is available in the WATERpak document at www.cottoncrc.org.au
First Flower Recommendations

At first flower the water use and nutrient uptake of the crop increases and the management becomes a juggling act to prolong the duration of flowering by minimising crop stress for as long as possible. In the lead up to first flower, assessments can be made on crop progress and adjustments can be made to management to achieve goals.

At first flower, crops should carry between 60 and 80 fruit per metre depending on the plant stand. Higher fruit loads at this time will have a tendency to burden the plant and management will need to recognise this and respond with water and nutrients prior to the boll load slowing crop growth.

**Total Nodes and Plant Height:** The aim is to have the plant growing healthily up to and through first flower. At first flower the aim would be to have in excess of 15 to 16 nodes (6 to 7 vegetative nodes, 8 to 10 fruiting branches). However, caution is warranted not to have the plant growing too vegetatively or excessively. At first flower, plant height is expected to be about 50 to 60 cm, aiming to have a frame that will support a high fruit load during the flowering period. New node vegetative growth rate should not exceed 6 to 7 cm per node at this time.

**Nodes Above White Flower (NAWF):** The NAWF measurement is a function of the rate of growth from first square to first flower. At first flower the aim should be to have the NAWF value in excess of 8 High NAWF values can be used as a shock absorber, enabling the crop to better cope with minor setbacks and stress such as a couple of days of hot temperatures.

Figure 7.1 Schematic of a cotton plant with 9 NAWF at First Flower
When it is lower than NAWF value of 8, the crop will need careful management through the flowering period to prolong the reproductive life of the crop. Higher NAWF figures can mean excessive growth, but they should be interpreted in conjunction with fruit load to see if further management is required to slightly check the plant.

Begin monitoring for NAWF when approximately half the plants have a pink or white flower on a fruiting branch. Count the number of nodes above the highest first position white flower, including the node nearest the terminal with an associated unfurled leaf approximately the size of a 5 to 10 cent piece.

NAWF should be monitored throughout the flowering period to help assess the performance of the crop. The longer a crop can be kept from flowering the higher the yield potential.

One thing you cannot plan for is the climatic conditions. All you can do is have the plant in the best possible shape to perform to its potential, no matter what the season throws at you. Having a plant conforming to these ideals will ensure that, regardless of seasonal conditions, the crop will be able to absorb and rebound from stress.

**Figure 7.2** Average daily water use of Australian cotton crops (29 crops 7 years)

**Figure 7.3** Average decay of NAWF for Gwydir region in 71/74BRF plants.
Cotton plant monitoring

To be able to manage irrigation timing, crop growth rates and targets, it is important to monitor the plant regularly with information on crop progress compared to targets. This will allow for more specific management and remedial action if required.

EARLY SEASON PLANT MONITORING

Plant population
Aim for a plant population of 8 to 12 evenly spaced cotton plants per metre row. Uniformity is as important as the plant population because it can impact not only the yield potential, but the growth and development of the young cotton plant.

Plant height and total main stem nodes
Monitoring these is important in determining the growth rate of the cotton seedling and can be used as an early indicator of crop health. Additionally, they are critical in correct growth regulator decisions and rate determinations. (see below)

Early season fruit retention
In full season areas the cotton plant is able to compensate for lower first flower retention figures. An understanding of the square retention is important because excessive losses in the lead up to first flower - either due to insects or environmental factors - will impact on insect control decisions. Aim for high retention figures at first flower in excess of 80 per cent.
**MEASURING VEGETATIVE GROWTH RATE (VGR) TO AID IN PIX DECISIONS**

Cotton is a perennial plant and has an inbuilt tendency for vegetative growth to dominate over the reproductive growth phase. The use of mepiquat chloride can on occasions assist with improving the ratio of reproductive to vegetative growth at and/or during early flowering, especially in very favourable growing conditions. Unnecessary or excessive use of the product can be detrimental to final yield however. The use of Vegetative Growth Rate (VGR) measurements can assist with decision making. Measurements should commence as the crop approaches first flower e.g. about 12 mainstem nodes. The monitoring should continue for the first half of flowering as rapid increases in growth can occur anytime in this period.

**Vegetative Growth Rate Determination**

On at least 20 randomly chosen plants,

1. Measure Plant Height (as described in Table 7.2)
2. Determine Total Nodes (as described in Table 7.2)

Carry out the same procedure a week later, and then use the following formula to calculate the VGR, the rate of internode increase (cm/node)

\[
\frac{\text{This week’s height} - \text{Last week’s height}}{\text{This week’s TN} - \text{Last week’s TN}}
\]

VGR values > 7.5 may indicate a need for the product. Table 7.3 indicates some of the other growth parameters that will also influence this decision making.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>How measured</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Height (cm)</td>
<td>From cotyledon scars to growth terminal</td>
<td>Target 50-60 cm</td>
</tr>
<tr>
<td>No. Vegetative Branches (VB)</td>
<td>Cotyledons excluded from count. Straight structures, no scars or squares</td>
<td>Range 4-7 generally</td>
</tr>
<tr>
<td>No. Fruiting Branches (FB) or Squaring Nodes (SN)</td>
<td>FB have slight angular change where square attached or scar (square absent)</td>
<td>8-10 at first flower is the target</td>
</tr>
<tr>
<td>Total Nodes</td>
<td>Uppermost SN is the terminal leaf</td>
<td>Range of 14-18 at first flower</td>
</tr>
<tr>
<td>Nodes Above White Flower (NAWF)</td>
<td>Total Sum of VB + SN</td>
<td>8-10 at first flower is target</td>
</tr>
<tr>
<td>First Position Retention (%)</td>
<td>Sum squares present at first position on FB, divided by total potential first positions on all FB</td>
<td>Range from 65-95% at first flower is target</td>
</tr>
</tbody>
</table>

Table 7.2 Some key growth parameters at first flower.
These indicators can be used at first flower to assess where a crop is up to in terms of vegetative growth and whether growth regulation is required. Only having one of these indicators does not necessarily mean growth regulation is required, but having several indicates a likely response to growth regulation.

During flowering it is important to monitor the crop internode growth. Another way of looking at ascertaining where the crop is up to is by looking at the 4th to 5th internode interval from the top of the plant, which gives a good understanding of what the crop is doing. This node represents 90% of its current length. If this node is longer than 7.5 cm look at the previous nodes 6th to 7th from the top and the younger nodes 3rd to 4th from the top. This will allow a comparison of 9-12 days growth and will help in understanding how the crop is tracking.

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**Table 7.3**

Growth Parameters at First Flower that indicate likely Pix® Response.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pix® Indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>&gt; 70 cm</td>
</tr>
<tr>
<td>Growth Rate</td>
<td>&gt; 2.5 cm per day</td>
</tr>
<tr>
<td>Node Growth Rate</td>
<td>&lt; 3 days per node</td>
</tr>
<tr>
<td>Max. Internode Distance</td>
<td>&gt; 7.5 cm</td>
</tr>
<tr>
<td>Vegetative Nodes</td>
<td>&gt; 7</td>
</tr>
<tr>
<td>Bottom Five Retention</td>
<td>&lt; 60%</td>
</tr>
<tr>
<td>Top Five Retention</td>
<td>&lt; 80%</td>
</tr>
<tr>
<td>NAWF @ First Flower</td>
<td>&gt; 8.5</td>
</tr>
<tr>
<td>Weather</td>
<td>Cloudy/Rain</td>
</tr>
<tr>
<td>Water Relations</td>
<td>Excessive</td>
</tr>
</tbody>
</table>

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**Figure 7.4** The VGR tool incorporating VGR measurements and other crop factors.

**Figure 7.5** Yield response Pix® in Bollgard II varieties with a comparison to previous work in conventional cotton. (S.Williams 2014)

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Acknowledgements and Further Reading

- Dr Michael Bange, Senior Principal Research Scientist, CSIRO. per coms 2015
- Dr Michael Braunack, Research Scientist, CSIRO. per coms 2015
- Sandra Williams, Experimental Scientist, CSIRO. per coms 2015
- Dr Stephen Allen, Senior Plant Pathologist, CSD. per coms 2015
- CSIRO cotton breeding team lead by Dr Warwick Stiller, Australian Cotton Research Institute, Narrabri. NSW
- CSD QA Team led by Brett Ross
- CSD Extension & Development Team
- Cotton Seed Distributors
  - 2014 Variety Trial Results - 2014
  - Management guidelines for growing high yielding cotton crops 2013
  - CSD Website Publications
    - Variety Performance Comparison
    - Soil Temperature Network
    - Seeds per Kilogram
    - Statement of Seed Analysis
    - Annual Disease Surveys
    - Replant Calculator
    - Seed Treatments
    - Effects of Planter Speed on Establishment
    - What Plant Stand should you aim to achieve?
  - Facts On Friday
    - Cotton Planting and Establishment: Part 1, 3/10/14
    - Cotton Planting and Establishment: Part 2, 10/10/14
    - Getting the Most Out of Sicot 74BRF, 17/10/14
    - Setting the Crop Up Early: Part 1, 24/10/14
    - Setting the Crop Up Early: Part 2, 31/10/14
    - High Yields - Early Season Growth, 14/11/14
    - High Yields - What to Expect at First Flower. 28/11/14
    - Why NAWF at First Flower is Important? 5/12/14
- Cotton Research and Development Corporation.
  - WEEDpak, Cotton Research and Development Corporation, 2002
    - Managing weeds in cotton. Charles, Roberts. 2002
  - Sampling method for the critical period for weed control. Charles, 2008
- Do Degree Days accurately describe rates of cotton development? Milroy, Bange. CRC for Sustainable Cotton Production.
- Efficient use of Nitrogen fertilisers. Rochester, Cotton Catchment Communities CRC
- Nutrient uptake and export from an Australian cotton field. Rochester, CSIRO, 2006
- Genetic improvement of cotton emerging technologies. Liu, Reid, Stiller, Constable. CSIRO, 2013
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