Tips and Tactics

Keeping sorghum safe

Northern Region

GRDC GROWNOTES® Know more. Grow more.

FEBRUARY 2016

Keeping sorghum safe when using metolachlor-based herbicides

To reduce seedling injuries, applying Concep® II seed safener is an essential step for growers.

KEY POINTS

- Weeds need to be managed well to achieve high yields.
- A lack of post-emergent herbicide options for grass control in sorghum means that pre-emergent control is often required. Metolachlor-based herbicides are frequently used.
- To reduce the potential damage to seedlings that come into contact with this herbicide, a seed safener (Concep® II) is required.
- Sandy/coarse/low organic matter soils are at a higher risk of herbicide damage.
- Many factors affect the level of exposure to and metabolism of metolachlor within the germinating seedling.
- Follow mixing and application guidelines to get the most out of Concep® II.

Key points influencing sorghum safety when using metolachlor-based herbicides

Factors INCREASING the chance of sorghum injury

- Rainfall or irrigation between planting and emergence wetting down to the seed zone, especially where waterlogging occurs.
- Light/sandy/gravel soils.
- Germinating seedling under stress (e.g. waterlogging, cold shock, insect damage).
- Maximum application rates.
- Marginal soil temperature at planting.
- Defined planting furrows that with rainfall, act to concentrate herbicide over the crop row.
- Shallow planting depth.

Factors REDUCING the chance of sorghum injury

- High quality seed, treated with Concep® II seed safener.
- Concep® II seed safener applied within the past 18 months.
- Closing up of the planting slot to avoid herbicide coming into contact with the sorghum seed.
- Excellent crop agronomy.

Figure 1: Symptoms of metolachlor injury includes distortion and crinkling of leaves. (Photo: Syngenta)

Metolachlor-based herbicide important to manage weeds

Weed competition during the establishment phase of sorghum can result in poor establishment, uneven maturity and harvest delays. Where weeds compete with the crop for nutrients and moisture, a yield penalty often occurs.

A limited range of post-emergent herbicide options are available for the control of broadleaf weeds in sorghum. However reliable and effective post-emergent herbicide options for grass weed control are limited to either inter-row cultivation, chipping or some suppression via high application rates of atrazine. Most growers rely on pre-emergent herbicides to establish a crop free from weeds for the first few weeks post-emergence, until crop competition from shading at row closure slows further weed germination. This is especially important in no-till farming systems where inter-row cultivation for weed control is undesirable.

One of the most common pre-emergent weed control strategies in sorghum is to apply a metolachlor-based herbicide. This is done either alone or in combination with a triazine herbicide such as atrazine (e.g. Gesaprim®) or terbuthylazine (e.g. Terbyne®). Where weeds have already become established before the metolachlor application, tank mixing with a non-selective herbicide will be required.

Various metolachlor-based herbicide formulations are currently available. Herbicide brands vary in the concentration of active ingredient and/or the isomer percentage. Isomers are compounds that have the same chemical formula, but the elements of the molecules are arranged slightly differently. This molecular arrangement can influence their effectiveness as a herbicide. Metolachlor formulations contain both the 'r' and the more active 's' isomer of metolachlor. S-metolachlor formulations contain a higher concentration of the more active 's' isomer, which allows a reduction in use rate of approximately 35% (on a grams of active ingredient per hectare basis) (Table 1).

Table 1: Table 1: Applications of different metolachlor herbicides providing equivalent grass weed control

Product	Equivalent application rate
960 g/L s-metolachlor e.g. Dual® Gold	2 L/ha
960 g/L metolachlor e.g. Clincher® Plus	3 L/ha
720 g/L metolachlor e.g. Bouncer®	4 L/ha

Sorghum tolerance to metolachlor-based herbicides

When metolachlor-based herbicides are applied at or prior to planting, it is highly likely that the germinating sorghum seedling will come into contact with some of the herbicide during germination and emergence.

Symptoms of metalachlor injury includes distortion and crinkling of leaves

(Top photo: Mark Congreve, ICAN)
(Lower photo: Trevor Philp, Pacific Seeds)

Sorghum has low to moderate tolerance of metolachlor, with reduced germination and crop injury typically occurring if using planting seed without a crop safener applied. Examples of damage can be seen in Figures 1 and 2. Maize is more tolerant than sorghum so a crop seed safener is generally not required, however injury can still occur under certain situations.

Use a seed safener on sorghum seed

As the germinating sorghum seed absorbs moisture from the soil, it will take up some metolachlor herbicide that is dissolved in the soil water. To successfully germinate and establish, the seedling needs to be able to metabolise this herbicide before toxic effects are expressed. Concep® II, a seed safener approved for use in Australia, increases the seedling's ability to metabolise metolachlor, therefore reducing the toxic effects.

Figure 2: Missing and damaged plants. (Photo: Syngenta)

How does Concep® II work?

During germination, some of the Concep® II treatment that has been applied to the seed coat enters the germinating seedling.
Concep® II increases the rate of metolachlor herbicide metabolism in the seedling, reducing the toxic effects of the herbicide (Price and Kelton 2013).
As Concep® II is on the seed coat of individual sorghum seeds, it is only taken up by that seedling and is not taken up by weed seeds.

It is important to note that Concep® II does not prevent the herbicide from entering the seedling, or modify or breakdown the herbicide in any way. As a seed safener, Concep® II simply helps the seedling metabolise and detoxify the herbicide more rapidly (Figure 3).

If a treated seedling comes into contact with an excessive quantity of herbicide, or if it is stressed (e.g. waterlogged) this may reduce the plants ability to metabolise the herbicide and crop injury may still occur, even when treated with Concep® II safener.

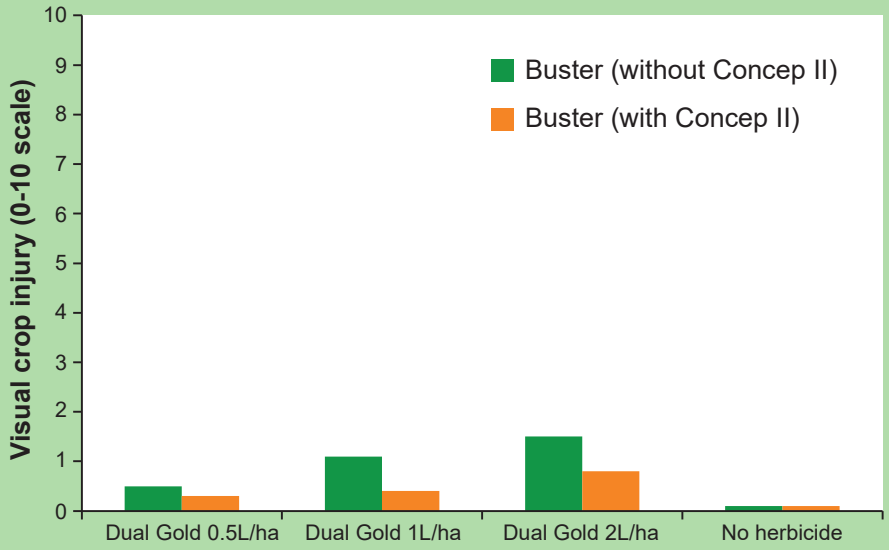

Figure 3: Results from a sorghum tolerance trial, conducted in Brookstead September/October 2011. Low levels of crop injury occurred with increasing rates of metolachlor (green bars). Treating the seed with Concep® II safener reduced the level of herbicide injury (orange bars). (Source: Syngenta)

Directions for mixing Concep® II on-farm

How to use Concep® II seed safener

Concep® II should be applied to the seed prior to planting. Growers can order sorghum seed that is already treated or treat their sorghum seed on-farm.

If applying on-farm, ensure that you:

- use high quality seed (high germination count and good seed vigour)
- apply Concep® II at the correct rate
- completely cover the seed
- do not store the seed for extended periods of time before planting.

Mixing and application guidelines (refer to Table 2)

1. Place the required amount of seed into a cement mixer.
2. While rotating, slowly add the required amount of water.
3. Once the seed is moistened, slowly sprinkle Concep® II at the required rate.
4. Continue to rotate for 1 to 2 minutes or until you adequately coat the seeds. Remember that the higher the volume of seed, the longer the mixing time required to maintain uniform coverage.
5. Do not store treated seed for more than 18 months.

(Photo: Carl Davies)

Table 2: The correct mixing and application rates. Sorghum seed to water to Concep® II rates.

Sorghum seed (kg)	Water rate (mL)	Concep® II rate (g)
20	200	36
25	250	45
30	300	54
40	400	72
50	500	90

(Source: Syngenta 2016)

Factors to consider when using metolachlor to avoid crop damage

Metolachlor-based herbicides are the main standard for pre-emergent control of grass weeds in sorghum. When used with Concep® II treated seed, metolachlor can be safely applied according to label directions prior to planting sorghum.

Many factors influence the amount of herbicide that comes in contact with the germinating seedling and the metabolism of this herbicide once inside the seedling.

Factors affecting metolachlor exposure to the germinating seedling

1. Herbicide rate

Metolachlor has a relatively short half-life, particularly where the soil surface remains moist and subject to microbial breakdown.

Applying maximum label rates will provide the longest period of weed control in the crop, however this may increase crop injury. Application at the higher end of the registered rate range will result in more herbicide dissolved in the soil solution, and therefore more herbicide available to be taken up by the germinating seedling, potentially increasing crop effect (Figure 4).

2. Timing of herbicide application

Depending on environmental conditions, when s-metolachlor is applied as per label directions (e.g. Dual Gold applied at 1–2 L/ha prior to, at or immediately post planting) growers should expect 6 to 10 weeks weed residual weed control.

Where the herbicide application has been applied a few weeks before planting, it is likely that significant herbicide breakdown will have already occurred before crop germination and emergence. This will increase crop tolerance, however it will decrease the length of in-crop residual weed control.

3. If metolachlor is incorporated into the soil

To provide effective weed control, metolachlor needs to be incorporated into the soil surface. If simply left on the soil surface without incorporation, accelerated loss can occur over a few weeks via photodegradation (UV light breakdown) and/or volatility loss. There are two main incorporation methods: mechanical and rainfall/irrigation.

A light mechanical incorporation after herbicide application is the most effective and consistent way of incorporating herbicide into the top 2–3 cm of soil, where the majority of the grass weed seeds are likely to germinate from.

If using rainfall or irrigation to incorporate metolachlor, the volume of water is likely to have a major bearing on where the herbicide moves within the soil profile. Metolachlor is moderately soluble so will easily move into the soil following rainfall or irrigation.

Ideally the first rainfall or irrigation event after the herbicide application would wet the soil to a depth of 3–5 cm and thus incorporate the herbicide to this depth. The majority of weed seeds will also reside in this zone in reduced or no-till farming systems. The amount of rainfall or irrigation required to achieve this level of incorporation will depend upon soil type, structure and existing moisture, however may often be as little as 5–10 mm of rain.

Should a larger rainfall or irrigation event occur after application, the herbicide is likely to move further down the profile and there is a much greater risk of higher concentrations of herbicide coming in contact with the germinating seed. Deeper herbicide movement below the root zone of surface germinating weeds may result in weed 'escapes'.

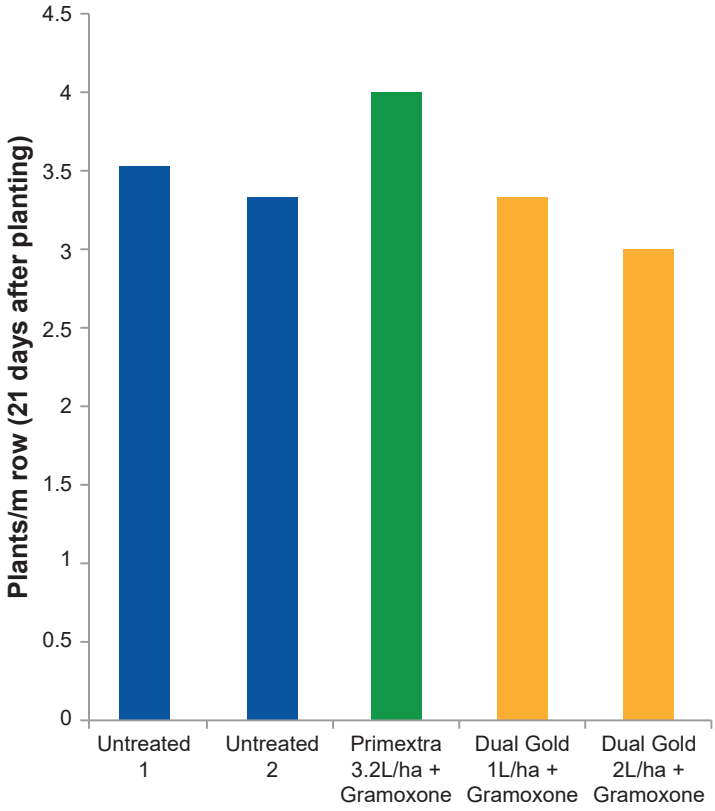

Figure 4: Sorghum establishment following three typical pre-emergent metolachlor herbicide treatments applied to Concep® II-treated sorghum seed. In this trial there was no statistical difference between any of the three treatments and the two untreated controls. However the highest rate of Dual Gold did result in established plant numbers slightly lower than the untreated controls, where no metolachlor was applied. (Source: Syngenta)

A worst case situation occurs where:

- large amounts of rainfall or irrigation result in high levels of herbicide in the available soil moisture
- the herbicide has been moved down to the germination zone of the sorghum crop
- there is associated waterlogging, reducing the plant's ability to detoxify the herbicide.

In these situations, emergence can be reduced and/or crops can be damaged.

4. Soil type

After incorporation, some herbicide will bind to the soil and organic matter while some will remain dissolved in the soil water. Soils with high clay or organic matter content have more binding sites and therefore bind more herbicide to the soil or organic matter. This means that less of the applied herbicide remains in the soil water.

During germination, the seedling imbibes freely-available water in the soil, which also contains dissolved herbicide. In sandy/coarse/low organic matter soils there is more available herbicide dissolved in the soil water, as a result it is generally these soil types where herbicide damage is most evident.

Figure 5: Weed escapes emerging down the crop row resulting from herbicide being removed from the furrow during the planting operation. (Photo: Mark Congreve, ICAN)

5. Pre-Plant versus Post-Sowing Pre-Emergent (PSPE) application

Applying the metolachlor-based herbicide and then following with the planting operation (i.e. a pre-plant application) may result in herbicide treated soil being thrown out of the planting furrow and into the inter-row. The degree of soil displacement will be dependent upon planter type and set-up.

In situations where there is no following rainfall or irrigation between planting and emergence to redistribute the herbicide in the soil water, this can result in less herbicide in the soil immediately above the emerging seedling. Where emerging seedlings come into contact with reduced herbicide levels as they emerge in the furrow, crop damage is less likely.

While throwing treated soil out of the furrow may reduce crop injury in some situations, the lower herbicide concentration can often result in weed escapes in the crop row (Figure 5).

Post-sowing pre-emergent applications, where the crop is planted and then the herbicide is applied, should result in an even soil coverage, including over the planting row. In this situation the emerging crop is likely to be exposed to higher herbicide concentration in the soil over the crop row.

6. Planter set-up

Setting up planters effectively may assist in reducing the potential for crop injury. Well set-up press wheels are generally recommended when planting sorghum to ensure good seed to soil contact to enhance crop germination. Effective slot closure and sealing by the press wheels is also beneficial to reduce the chance of herbicide being washed directly down the planting slot and into contact with the sorghum seed.

Figure 6: Summer crop planter with chains and covering harrows. (Photo: Trevor Philp, Pacific Seeds)

Planter set-ups that leave a defined planting furrow may assist in directing small rainfall events into the furrow, potentially beneficial for sorghum germinating under drier conditions. However this channelling of rainfall may increase the concentration of herbicide directly over the planting row. To remove furrows, covering harrows or chains installed behind the planter can level the soil surface (Figure 6). Harrows or chains will also assist in mechanically incorporating the herbicide. If herbicide treated soil is concentrated in the furrow immediately above the seed row, there could be more crop damage in some situations. Using looped chains behind a seeding row can concentrate herbicide immediately above the seed row and increase the risk of crop injury.

7. Planting depth

Depth of planting may influence the amount of herbicide coming into contact with the germinating seed. Deeper planted seed will increase the physical separation between the metolachlor herbicide applied to the soil surface, especially where there has not been significant rainfall or irrigation to move the herbicide down the soil profile.

Conversely, deep planted seed will take longer to emerge, especially under conditions of marginal soil temperature and moisture. Therefore the seedling is likely to have more difficulty in metabolising any herbicide that has been imbibed, before it emerges and photosynthesis can commence.

Factors affecting metolachlor metabolism within the seedling

Metolachlor injury may still occur to sorghum treated with Concep® II safener. Often where damage occurs it is commonly associated with another compounding factor that reduces the ability of the seedling to rapidly metabolise the herbicide.

Under situations conducive to excellent establishment of sorghum, growers will seldom see damage. There are six key factors that affect the seedling's ability to metabolise the herbicide.

1. Concep® II seed safener

Applying Concep® II to the sorghum seed prior to planting assists the seedling to metabolise the metolachlor herbicide faster. Concep® II may be unable to provide the needed level of crop safety under environmental conditions that retard metabolism.

2. Waterlogging

This is often one of the most common factors contributing to increased sorghum injury when using metolachlor-based herbicides.

Seedlings need to be able to take up water and oxygen from the soil during germination and emergence. If the soil is saturated and therefore devoid of oxygen, the germinating seedling will become stressed and metabolism will slow, or stop, until the water drains and oxygen returns to the soil pores. Where waterlogging has occurred and the seedling has already taken up the herbicide, it may not be able to rapidly detoxify the herbicide. The result will be expressed as reduced seedling emergence and/or visual herbicide damage.

3. Soil temperature

The critical soil temperature for germination and emergence of sorghum is generally considered to be 16°C. Soil temperature should be measured at 7am by inserting a temperature probe parallel to the ground at the required planting depth.

Where soil temperature falls below 16°C, growth and emergence is delayed. This may increase the expression of metolachlor symptoms, as herbicide metabolism will be slower.

Research from the Queensland Department of Agriculture and Fisheries shows that sorghum takes 11–14 days to emerge at 15°C, while only 7–10 days at 17°C (QDAF 2011).

4. Insect damage

Defoliation or root pruning will reduce the plant's ability to emerge or photosynthesise after emergence. This reduces the plant's ability to quickly metabolise the metolachlor herbicide.

5. Seed variety

There are no current varieties that are known to be significantly more sensitive to metolachlor-based herbicide (Figure 7). However, as with any herbicide, there are likely to be small differences in selectivity between varieties.

6. Seed vigour and germination percentage

Seed is a living organism. Different lines of seed within the same variety will often have different levels of germination and vigour due to the environmental conditions experienced during their production.

Hybrid seed suppliers test every seed production line before Concep® II is applied, with only the most robust lines selected for Concep® II application.

Reduction in germination percentage and/or seed vigour often occurs when seed is stored between seasons; with some evidence that Concep® II treatment may further increase this rate of reduction over time. Growers should avoid carrying over Concep® II-treated seed between seasons, where possible.

Planting with leftover Concep® II-treated seeds

Assuming the germination percentage is deemed as acceptable, the safest use for this carry over seed is to plant it into paddocks that are known to be free of grass weeds, and therefore where a metolachlor-based herbicide is not required.

However, if the only planting opportunity is into a paddock where a metolachlor-based herbicide must be used, then:

- delay planting until soil temperature is good (not marginal)
- avoid light, sandy or gravelly soils
- use application rates towards the lower end, based on the information on the metolachlor herbicide label
- ensure good subsoil moisture (for crop establishment) while avoiding planting in front of a predicted rainfall event or heavy irrigation, as these can move the herbicide down to the sorghum germination zone.

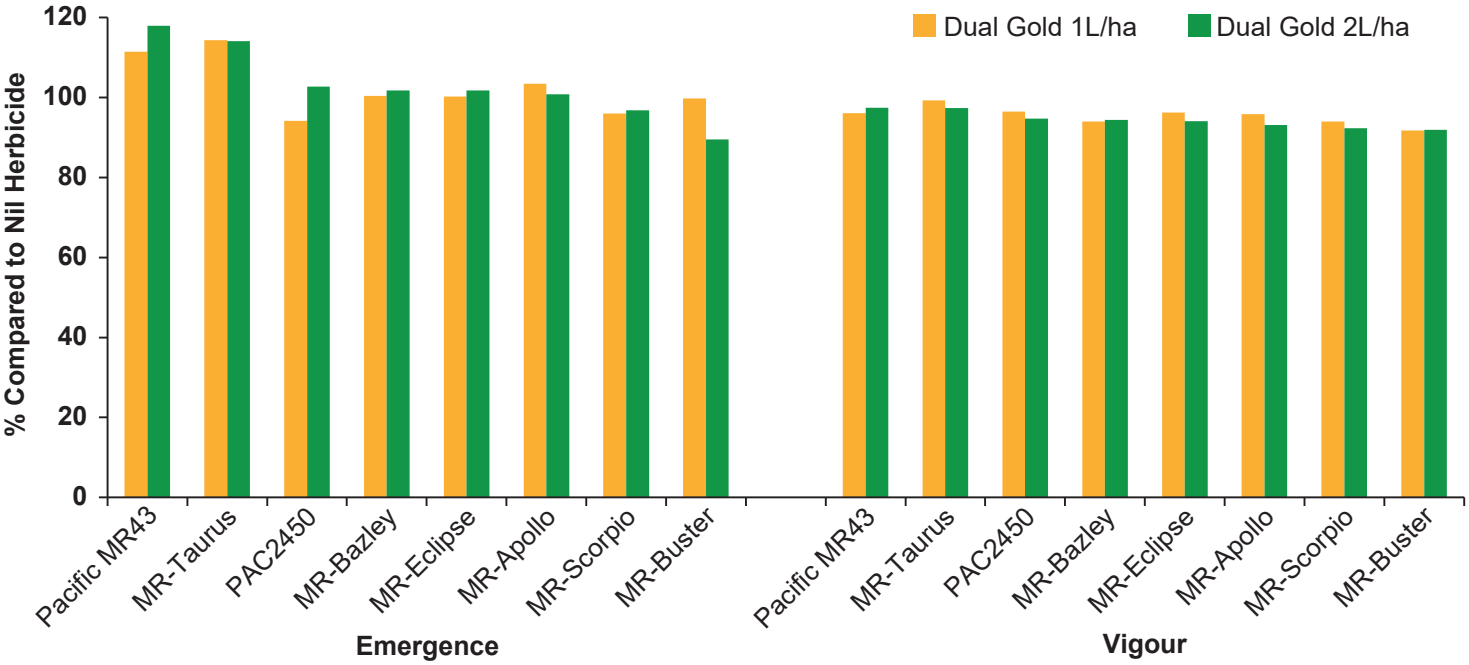

Figure 7: Results from varietal tolerance screen conducted in Gatton October 2012. The results highlight that there was very little varietal difference in tolerance to Dual Gold between commercial hybrid lines when Concep® II seed treatment has been applied to planting seed. (Source: Pacific Seeds/Syngenta)

FAQs

I have Concep® II-treated seed left over from last season. What can I do with it?
A germination test should be conducted immediately prior to the planting opportunity. This will give some indication as to the effect of storage on the individual line.

There is no practical test to determine seed vigour. However, where germination percentage is still high, experience suggests that adequate seed vigour usually remains.

Can my seed supplier tell me about my seed?
Some seed suppliers maintain germination information on individual lines by periodically re-testing retained samples. If relying on this information from the seed supplier's retained samples, it is important to understand that these have been stored under ideal conditions, which may be different to storage conditions on-farm. If seeking germination percentage information from the seed supplier, ensure you find out when the testing was conducted.

How long can I keep Concep® II-treated sorghum seeds?
Do not keep Concep® II-treated sorghum seed for more than 18 months.


(Photo: Carl Davies)

Contact

Mark Congreve
ICAN
0427 209 234
mark@icanrural.com.au

Useful resources

GRDC Integrated Weed Management Hub.
http://grdc.com.au/Resources/IWMhub

GRDC GrowNotes for Sorghum.
http://grdc.com.au/Resources/GrowNotes

References

Price, A.J. and Kelton J.A. eds (2013) Herbicides - Current Research and Case Studies in Use, ISBN 978-953-51-1112–2, InTech. URL: http://www.intechopen.com/books/herbicides-current-research-and-case-studies-in-use

QDAF (2011) Sorghum - planting information. URL: www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/sorghum/planting-information

Syngenta (2016) Concep® II: Managing & mixing Concep® II for best results, Syngenta. URL: http://www3.syngenta.com/country/au/SiteCollectionDocuments/Product.Plus/All%20technotes/TN10-124%20%20Concep%20II%20-%20Managing%20and%20Mixing%20Concep%20II%20for%20best%20results.pdf

GRDC project code

ICN00016

Acknowledgements

Mark Congreve and John Cameron, ICAN; Trevor Philp, Pacific Seeds; Shaun Hood, Syngenta.

Produced by Seedbed Media
www.seedbedmedia.com.au

® Registered trademark

GRDC Grains Research & Development Corporation
Your GRDC working with you

ICAN Independent Consultants Australia Network