



SOUTHERN

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GRAINS RESEARCH
& DEVELOPMENT
CORPORATION

FABA BEAN

SECTION 11

PRE-HARVEST TREATMENTS

KEY POINTS | PURPOSE | CORRECT TIMING BASED ON SEED AND POD
DEVELOPMENT | DESICCATION | WINDROWING | CROP-TOPPING | CHEMICAL
PRODUCTS REGISTERED FOR USE IN FABA BEAN

Pre-harvest treatments

Key points

- Desiccation and windrowing can be used to enable earlier harvest and to dry out green weeds. They assist with uniform ripening of the crop.
- Crop-topping is primarily used to minimise weed seedset and is based on the maturity of the target weed. In most cases beans will not be fully mature when crop-topping for weed management and there will be some yield penalty, but this may be necessary to achieve control of particular problem weeds such as herbicide-resistant weeds.
- Weed wiping is not suitable for beans as even the shorter varieties are too tall relative to weeds such as ryegrass.
- Do not use glyphosate on crops intended for use as seed or for sprouting markets, even when applied after physiological maturity, as it reduces seed viability.

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MORE INFORMATION

GRDC Fact Sheet, Pre-harvest herbicide, www.grdc.com.au/GRDC-FS-PreHarvestHerbicide

Pulse Australia has information on desiccation and crop-topping in pulses, see <http://pulseaus.com.au/growing-pulses/publications/desiccation-and-croptopping>

11.1 Purpose

Pre-harvest treatments to assist with harvest and weed management include:¹

- Desiccation — herbicide is applied to a mature crop to remove moisture from the crop and any green weeds to enable an earlier harvest. Faba bean is well suited to desiccation and this is becoming common practice.
- Windrowing — cutting the crop to assist with direct heading, uneven crop maturity, drying green weeds or for weed seed management. Windrowing should be used if direct heading is likely to be a problem and should not be necessary every year.
- Crop-topping — herbicide is applied specifically to reduce weed seedset with minimal damage to the crop. In longer growing season environments faba bean mature too late to crop-top successfully without damaging seed yield and quality.
- Weed wiping — herbicide is applied to weeds that project above the crop canopy. While this technique is widely used in other pulse crops it is not suitable for beans as even the shorter varieties are too tall relative to weeds such as ryegrass.

Desiccation and windrowing are primarily used to enable earlier harvest and to dry out green weeds. Timing is based on the maturity of the crop.

Crop-topping is primarily used to minimise weed seedset and its timing is based on the maturity of the target weed. It is essential to ensure that the crop is mature enough so that the seed is not damaged. Crop-topping uses different chemical products or rates to desiccating.

Desiccation and crop-topping can reduce seed viability depending on the timing and product used. They are not recommended for crops intended to be saved for seed.²

¹ Pulse Australia (2016) Southern faba & broad bean best management practices training course – 2016. Pulse Australia

² Pulse Australia (2016) Pulses: Desiccation and crop-topping. Pulse Australia, <http://pulseaus.com.au/growing-pulses/publications/desiccation-and-croptopping>

11.2 Correct timing based on seed and pod development

Seed is at its maximum size and weight once a seed is physiologically mature. Faba bean maturity can vary substantially both within the plant and between different parts of the paddock. Both soil type and disease severity can influence seed maturity.

Lower pods will mature before the upper pods. In commercial crops it is common for the lower 30% of pods to have dried below 15% seed moisture content (seeds detached from the pod) while the upper 25% of pods on each branch are still at 30–40% moisture and at varying stages of maturity.

Take samples from a number of sites within a paddock to accurately assess seed maturity in both upper and lower pods.

Select a representative stem or branch from each of the plants sampled.³ Start at the bottom of the plant and check one pod at each node moving up the stem (Figure 1). Remove the seeds from each pod and check the hilum to determine maturity. The hilum is the scar-like part of the seed where it is attached to the pod (Figure 2). A mature seed will have a black line on the hilum. Plants will still be green when the hilum has started to turn black.

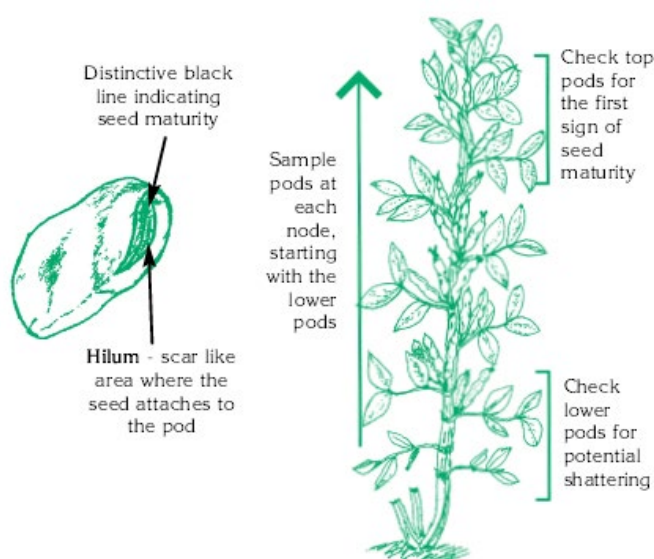


Figure 1: Check maturity of pods from the bottom of the plant to the top.

Source: Matthews and Carpenter (1999) NSW DPI

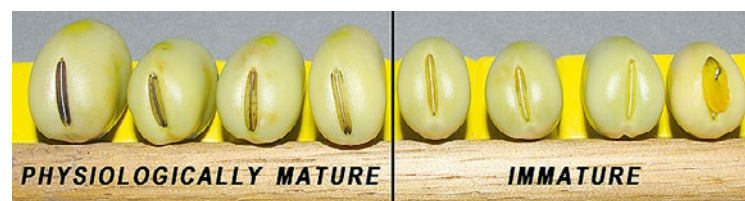


Photo 1: Faba bean seed is mature when the hilum has started to turn black.

Photo: Gordon Cumming, Pulse Australia

Seed maturity is the only way to fully determine crop maturity. Using alternative measures such as leaf senescence or the colour of lower pods is misleading as they may be influenced by disease.

³ P Matthews, D Carpenter (1999) Windrowing faba beans. Pulse Point 9, NSW Agriculture, <http://www.dpi.nsw.gov.au/content/agriculture/broadacre/winter-crops/pulses/beans/windrowing-faba>

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Correct timing is essential to ensure that both yield and grain quality are not compromised. Desiccation, crop-topping and windrowing will stop seed from maturing further.

Timing is similar for desiccation and windrowing. The ideal timing for crop-topping is more dependent on balancing the correct stage of weed development with suitable timing for crop maturity. Understanding and measuring seed maturity is essential.

Crop maturity will vary within a plant and across a paddock so timing will always be a compromise between too early or too late depending on the purpose of the activity.

11.3 Desiccation

The purpose of desiccation is to ensure an even ripening of the crop and to 'brown-off' late weed growth for earlier and easier harvesting.⁴ It is particularly useful when there is uneven ripening across the paddock. Desiccation can advance maturity by up to 10 days.

The optimal stage to desiccate the crop is when the vast majority of seeds have reached physiological maturity, i.e. 90–95% of the crop. This is when the hilum is turning black on the seeds in the uppermost (25%) pods (Figure 2). At this stage the upper pods are still bright green, there is still green leaf present, but the lowest pods are starting to turn black and have seeds with completely black hilums.

Applying desiccants to seed that is still green and actively filling will result in:

- a reduction in grain size (and yield);
- an increase in a greenish discolouration of the seed coat; and
- a reduction in seed viability (dead or abnormal seed).

Do not use glyphosate in faba bean crops intended for use as seed or for sprouting markets, even when applied after physiological maturity. It can substantially reduce seed viability (Table 1).

Table 1: The effect of desiccation and windrowing timing on seed viability.

Treatment	Crop stage	Normal seed (%)	Abnormal seed (%)	Total germinated (%)
Nil pre-harvest treatment		92	2	94
Desiccated – glyphosate	Seed physiological maturity	27	63	90
	Seed physiological maturity + 6 days	64	29	93
Windrowed	Seed physiological maturity	89	2	91
	Seed physiological maturity + 6 days	85	7	92

Source: Matthews & Holding (2004) via Southern faba & broad bean best management practices training course 2016

Herbicide rates for desiccation are higher than required for crop-topping.

Harvest 5–10 days after desiccation. Observe all withholding periods to avoid chemical residues in grain.

⁴ T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, <https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/>

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MORE INFORMATION

A fact sheet on 'Windrowing faba beans' is at

<http://www.dpi.nsw.gov.au/content/agriculture/broadacre/winter-crops/pulses/beans/windrowing-faba>

A GRDC Update paper on 'Direct heading v. windrowing' is at <https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2010/09/Faba-beans-Direct-Heading-vs-Windrowing>

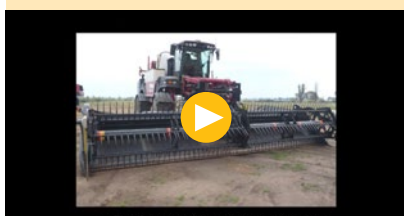
VIDEO

Swathing faba bean, <https://youtu.be/5JonEwOa6HM>



VIDEO

Windrowing and harvesting faba bean, <https://youtu.be/ijm1TLt5jNI>



11.4 Windrowing

The purpose of windrowing is to reduce problems associated with direct heading, uneven crop maturity or weed seed management. The technique can bring the harvest date forward (Figure 3), uniformly ripen the crop and protect from shattering where harvest is to be delayed. It can also reduce weed seedset.

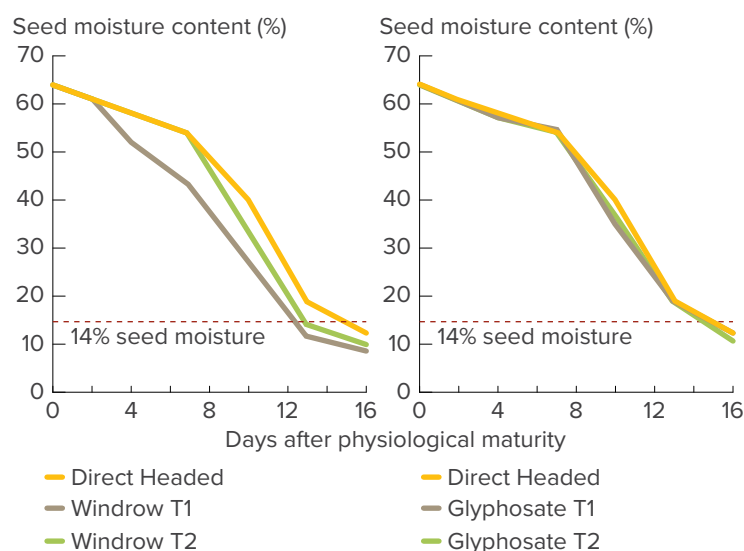


Figure 2: Moisture content of faba bean at harvest: comparison of windrowing (left) or desiccation (right) with direct heading with no pre-harvest treatment.

Source: Matthews & Holding (2004)

The timing for windrowing is similar to desiccation and should be based on seed maturity (see [Section 11.2 Correct timing based on seed and pod development](#)).

Windrowing too early can cause yield loss as seeds are not filled, and small or shrivelled seeds classed as defective. This can reduce quality, causing downgrading from human consumption markets to stockfeed grade.

The earliest a bean crop should be windrowed is when the top pods are mature, as indicated by the blackening of the seed hilum.

IN FOCUS

The advantages of windrowing beans are:⁵

- Uniform maturity of the crop for harvest.
- Earlier harvest is possible at higher grain moisture content, avoiding clashes with cereal harvest.
- Early harvest with fewer losses where lodged.
- Reduced pod splitting and shattering after rain.
- Lower cutter-bar height, enabling lowest pods to be harvested.
- Reduced damage to headers working in rougher country. Sticks and stones can damage knife fingers and sections, retractable fingers and other components. Using pick-up fronts to harvest windrows will leave most of these on the ground.
- Better handling of excessively tall crops. In tall crops the harvester reel can push plants forward, causing problems feeding material into the harvester, and leading to grain loss as the cutter bar causes vibration and pod shattering in front of the harvester. Direct heading of tall crops can also be very slow, so windrowing can increase harvest efficiency.
- Late-maturing weeds are dried to enable earlier harvest. This reduces the risk of seed staining, quality downgrading and storage problems from green weed contamination. Staining of seed by green weed trash can be avoided. Heat build-up during storage by green weed trash is avoided.
- Weed seed is moved into a windrow that can be burnt after harvest.
- Better crop survival when harvest is delayed through reduced shattering and lodging.
- Reduced snail contamination in the sample, if windrowed late directly in front of the harvester.
- Harvest efficiency where two windrow widths are harvested in one pass of the harvester.

Windrowing is often used if directing heading is likely to be a problem and should not be necessary every year.

Disadvantages of windrowing:

- An extra paddock operation and cost is involved.
- Windrowing too early (prior to crop maturity) can cause significant yield and quality losses. Small and shrivelled seed will result from drying-down of immature seed.
- Windrowing too late can cause shatter losses as the cutter bar hits the crop.
- Heavy rain on windrowed beans may downgrade quality.

If windrowing is too early some cotyledons may stay green and affect marketability.

⁵ T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, <https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/>

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Windrowing too late can result in shattering losses. Lower pods may be more advanced than the top pods and may become brittle and shatter when windrowed. Disease, a spell of hot windy weather or moisture stress can cause the lower pods to ripen prematurely. Windrowing can only be delayed in cold and moist conditions.

The crop will not mature evenly, so it is important to select a timing that balances potential for lower pod shattering and possible yield losses from immature top pods.

When windrowing faba bean set, the cutting height just below the bottom pods, with the reel following the top of the crop. Use a slow reel speed.

Ensure the delivery opening in the windrower is large enough to prevent blockages that will result in lumpy windrows.⁶ Use a maximum windrower width in bulky crops to avoid problems with windrowing, extended drying time or harvesting of excessively large windrows. A dense and tightly knit windrow will produce the best results ([Photo 1](#)).

Curing usually takes 10–12 hot days but could take longer if there are green weeds ([Photo 2](#)). Adverse weather conditions between windrowing and harvest may result in losses, as with any other windrowed crop.

Windrowed crops can contain more dirt, particularly if rain has fallen on the windrow.⁷ Avoid placing the windrow onto wheel tracks, particularly in controlled-traffic area paddocks. Avoid particularly bulky windrows as these will take longer to dry. Likewise, avoid windrowing smaller crops where the smaller windrows may be difficult to pick up and the cost cannot be recouped.

Pick-up fronts are the most common type used for harvesting windrows. However, crop lifters used close together on open fronts have been used with some success.

Birchip Cropping Group (BCG) trials from 2001 in the Wimmera showed that direct heading could be a better option than windrowing.⁸ Windrowing reduced yield and quality, even at the preferred windrow timing, when seed at the top had a distinct black hilum. Seed discolouration in the windrow resulted from rainfall and contact with moist soil.

A 2008-09 survey of faba bean growers in northern NSW found that windrowing generally produced fewer harvest losses than direct heading, but that direct heading could achieve similar success rates if done carefully.⁹ When prices are low direct heading can be more profitable. Factors to consider for successful windrowing included:

- correct timing;
- size of the windrow – having enough material to feed into the pick-up front;
- skill and speed of the swather operator – use a reliable contractor and adjust the speed;
- placement – it is difficult to pick up windrows in wheel tracks; and
- level ground – hollows and ridges make it difficult to place and pick up the windrow.

South Australian Research and Development Institute (SARDI) trials from 2013 to 2015 at three locations in South Australia showed that windrowing and crop-topping did not reduce seed quality (size, staining, mould, etc).¹⁰ However, a delayed late harvest after windrowing or crop-topping (e.g. leaving the windrow a longer period before pick-up) did reduce seed quality. In general, the older varieties (Fiesta VF, Nura[®])

6 T Weaver (2015) Profitable pulses – it's all about the harvest window. GRDC GroundCover™, Issue 118, September–October 2015, <https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-118-Sep-Oct-2015/Profitable-pulses-its-all-about-the-harvest-window>

7 P Matthews, D McCaffery, L Jenkins (2016) Winter crop variety sowing guide 2016. NSW DPI Management Guide. NSW Department of Primary Industries, <http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide>

8 Birchip Cropping Group (2002) Faba beans – windrowing vs direct heading 2001. Online farm trials website <http://www.farmtrials.com.au/trial/13605>

9 M Parker (2010) Faba beans: direct heading v. windrowing. GRDC Update Papers, 21 September 2010, <https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2010/09/Faba-beans-Direct-Heading-vs-Windrowing>

10 J Davidson, R Kimber, C Walela, L McMurray, K Hobson, J Brand and J Pauli (2016) Pulse diseases in 2015. GRDC Updates Paper, 9 February 2016, <https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Pulse-diseases-in-2015>

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were more vulnerable to deterioration in seed quality than the newer varieties (PBA Rana[®], PBA Samira[®] and PBA Zahra[®]). Note that the trial was set up to evaluate the impact of windrowing and crop-topping on the development of field mould, but conditions were too dry.



Photo 2: *Faba bean windrows.*

Photo: Wayne Hawthorne, formerly Pulse Australia



Photo 3: *Inside an opened faba bean windrow.*

Photo: Wayne Hawthorne, formerly Pulse Australia

MORE INFORMATION

The DPIRD website has information on crop-topping pulse crops, including ryegrass stages for crop-topping, at <https://www.agric.wa.gov.au/lupins/crop-topping-pulse-crops>

Pulse Australian web alert: Desiccation and crop-topping in pulses, <http://pulseaus.com.au/growing-pulses/publications/desiccation-and-croptopping>

11.5 Crop-topping

Crop-topping is primarily used to minimise weed seedset and is based on the maturity of the target weed. However, it is essential to ensure that the crop is mature enough to prevent damage to the seed. Correct timing is critical.

Crop-topping will also bring forward the harvest date (Photo 4).



Photo 4: *Crop-topping. Missed strip during crop-topping shows later maturity than the crop that has been crop-topped.*

Photo: Wayne Hawthorne, formerly Pulse Australia

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Most faba bean varieties mature too late to crop-top successfully without damaging seed yield and quality. It is only suitable for earlier-maturing varieties of faba bean. Broad bean generally matures too late for crop-topping.

The risks of crop-topping are:

- Topping too early can reduce crop yield by increasing the number of small, immature seeds.
- Topping too early can damage seed quality through discoloured cotyledons (kernel) and seed coats.
- Rain soon after topping can make seed more vulnerable to seed staining.

The benefits of crop-topping are:

- To control seedset in late-germinating or herbicide-resistant weeds such as ryegrass.
- To dry-off late-maturing weeds to reduce high moisture or contamination of harvested grain.
- To stop crop growth and help to mature beans earlier.

Crop-topping is not recommended for crops that are to be kept for seed or sprouting. The risk of reduced seed viability is dependent on the timing and product used. Desiccation, but not with glyphosate, is a better option for seed crops.

To minimise the further development of glyphosate resistance in grass weeds, growers are encouraged to use alternatives wherever possible, e.g. to use paraquat for crop-topping in pulses rather than glyphosate, due to the high number of glyphosate crop-topping uses in other crops.¹¹

Crop-topping with glyphosate or paraquat can reduce viable seedset in ryegrass by 90%.¹² However, in practice, crop-topping controls 70–80% of seedset as it is generally applied later to reduce the risk of reducing crop yield.

For ryegrass control, glyphosate can be applied at the lower recommended rate when the ryegrass is flowering or at the higher label rate when the ryegrass is at the milky dough stage (label).

For ryegrass control, paraquat should be applied at the milky dough stage. This is ideally when the last of the seeds have emerged at the bottom of the plant and the majority are at or just past flowering. It should be before haying-off is observed. Higher rates will provide better reduction of seedset, but is also more likely to result in crop damage and yield reduction.

At the milk stage paraquat is more effective on ryegrass seedset (64–97% control) than glyphosate (14–74% control).¹³

The preferred timing for ryegrass seedset is often before the crop has fully matured and topping early can lead to yield losses of more than 25%.

Radish needs to be sprayed at the pre-embryo stage and for most bean crops this will pose a significant threat to crop maturity. The effectiveness of crop-topping for radish control is lower because of the indeterminate flowering of radish that means it flowers over an extended period of time.

SARDI trials in 2009 found that there was no general yield loss when crop-topping at the recommended time. However, there was an average loss of 9% in grain weight (Table 2). A hot and dry November led to early senescence of bean varieties and reduced grain yields in later maturing varieties. This may have masked responses to the crop-topping treatments. Results showed that:

- Manafest was the only variety to show a yield loss at the recommended timing based on ryegrass seed stage. Breeding line 2 (early maturing) was the only

11 J Davidson, R Kimber, C Walela, L McMurray, K Hobson, J Brand and J Paull (2016) Pulse diseases in 2015. GRDC Updates Paper, 9 February 2016, <https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Pulse-diseases-in-2015>

12 MJ Walsh and SB Powles (2007) Management strategies for herbicide-resistant weed populations in Australian dryland crop production systems. Weed Technology, 21, 332-338.

13 GRDC (2014) Pre-harvest herbicide use Fact Sheet. GRDC, October 2014, www.grdc.com.au/GRDC-FS-PreHarvestHerbicide

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variety to show no loss of grain weight. Breeding line 2 also showed the least grain yield loss (73% of untreated, but not significantly different) with early crop-topping.

- When crop-topped 3 weeks earlier than the recommended ryegrass stage, faba bean yields ranged from 49–73% to that of untreated (27–51% yield loss).
- When crop-topped at the recommended stage, yields were 73–98% that of untreated (2–27% yield loss).
- When crop-topped 2 weeks after the optimum ryegrass stage, yield was 71–107% of untreated.
- Grain size was affected by crop-topping, being reduced to 73% of untreated when crop topped 3 weeks early, 91% at the recommended stage and unaffected when crop topped 2 weeks late. Visual grain quality may have been affected to prevent delivery under national receival standards.

Table 2: Impact of crop-topping timing on faba bean varieties of differing maturity, Cockaleechee SA, 2009.

	Yield (t/ha)	Yield (% of nil) for each timing			Grain weight (g/100 seeds)	Grain weight (% of nil) for each timing		
	Nil	Minus 3 weeks (8/10/09)	Recommended* (19/10/09)	Plus 2 weeks (2/11/09)	Nil	Minus 3 weeks (8/10/09)	Recommended (19/10/09)	Plus 2 weeks (2/11/09)
Line 1 (L)	1.39	64	98	94	81.1	87	91	100
PBA Rana [Ⓛ]	1.56	49	84	92	83.9	83	89	99
Line 2 (E)	1.14	73	87	107	62.3	80	96	103
Line 3 (E-M)	1.39	61	90	91	75.8	82	94	101
Line 4 (M)	1.30	53	82	81	62.1	85	88	99
Doza [Ⓛ]	1.19	67	89	102	56.0	85	92	103
Farah [Ⓛ]	1.22	63	92	79	65.8	88	92	99
Fiesta VF	1.46	51	84	101	65.1	84	90	103
Fiord	1.18	67	80	103	52.3	73	87	101
Line 5 (E)	1.24	21	74	71	65.6	74	85	94
Manafest	1.48	66	73	79	84.5	90	90	101
Nura [Ⓛ]	1.43	58	87	96	63.3	86	91	99
Mean (t/ha)	1.33	0.80	1.13	1.22	68.1	16.3	15.9	18.2
Mean (g/100)						56.8	61.7	68.2

Shading denotes significantly different to the nil treatment
(E) = early maturing breeding line, (M) = medium maturing, (L) = late maturing
* Recommended is the date that is ideal for crop topping ryegrass

Source: A Ware, M Lines and L McMurray (SARDI) Southern Pulse Agronomy Research Trials via Pulse Australia (2016) Southern faba & broad bean best management practices training course

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MORE INFORMATION

AVPMA Webpage: PubCRIS database,
<https://services.apvma.gov.au/web/guest/pubcris>

11.6 Chemical products registered for use in faba bean

Pre-harvest chemical application to crops increases the risk of detectable herbicide residues in harvested grain, potentially leading to breaches of maximum residue limits (MRLs).¹⁴ MRLs vary according to herbicide, crop and market and these need to be understood. Detection of chemical residues above MRLs will jeopardise market access and the future of the Australian grains industry. See <http://www.agriculture.gov.au/ag-farm-food/food/nrs> for details of the National Residue Survey conducted annually across all grains.

Follow product labels correctly and adhere to withholding periods for harvest and grazing or cutting for stock feed (GSF) (Table 3).

Glyphosate is not registered for seed crops and should not be used in pulses intended for seed production or sprouting

Table 3: Registered products for desiccation and crop-topping of faba bean.

Herbicide	Example trade names	Operation	Rate	Withholding period
Diquat 200 g/L	Reglone®	Desiccation	2—3 L/ha	Grazing/stock feed (GSF*): 1 day Harvest: 2 days
Paraquat 250 g/L	Gramoxone®	Crop-topping	400—800 mL/ha	GSF: 1 day (7 days for horses) Stock must be removed from treated areas 3 days before slaughter Harvest: 7 days
Glyphosate 500 g/L	Touchdown Hi Tech®	Crop-topping	300—700 mL/ha	GSF: 7 days Harvest: 7 days
Glyphosate 570 g/L	Roundup Ultra Max®	Crop-topping	300—645 mL/ha	GSF: 7 days Harvest: 7 days
		Desiccation	645 mL/ha to 1.7 L/ha	GSF: 7 days Harvest: 7 days

* GSF = withholding period for grazing or cutting for stock feed
 Observe the harvest withholding period and GSF for each crop.
 Always read the label supplied with the product before each use.
 Source: Pulse Australia (2016) Pulses: Desiccation and crop-topping