CROP SCIENCE SOCIETY
OF SA INCORPORATED

Welcome to the October issue of the Crop Science Society of SA newsletter; issue 349

Dear CSSSA Members,

Welcome to the October issue of the Crop Science Society of SA, issue 349.

In this month's newsletter we explore:

- Rethinking your approach to canola harvesting
- Lentil varieties for low rainfall and sandy soil environments
- Preharvest sprouting in wheat

We hope you are keeping well. Please contact us if you have any requests for content of information.

Kind regards,

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President, Crop Science Society of South Australia

Rethinking your approach to canola harvesting

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[1]Grain Orana Alliance.

GRDC project code: GOA00002 Keywords

- Canola, Windrowing, direct heading, desiccation, pod shatter,

Take home messages

- Timing of windrowing of canola can have a huge impact on profitability through its influence on yield and oil%.
- Profit could be reduced by up to $50/day for every day that crops are windrowed before they are ready
- The window for windrowing on time is relatively small.
- Direct heading of canola is a viable and comparable alternate to well-timed windrowing, but may easily outperform crops that are windrowed before they are ready
- In contrast, the window for direct heading crops to maximise yield and profit may be much larger than those that are windrowed
- Desiccation, other than that for weed control, in many cases will not significantly speed up the crop maturity

Background

Windrowing of canola in the central west of NSW has been the traditional approach adopted by most growers. Recent survey data collected in 2017 by Grain Orana Alliance (GOA), a GRDC Grower Solutions Group, indicates that a decade ago between 65% - 80% of canola growers windrowing was used exclusively (GOA, unpublished).

In 2009 GOA was asked to investigate if windrow timing (WRT) was potentially impacting on canola performance, in particular, oil % of harvested grain, which can impact on crop profitability. In response, GOA established two trials in 2009 that compared different windrow timings. In both trials, the early windrowing resulted in significant yield penalties of up to 0.5t/ha, but only low levels of impact on oil% of the grain.

The outcomes from these two trials inspired many subsequent trials undertaken by GOA, not only investigating the impact of WRT but investigating the fit of direct heading, the use of desiccants, the use of PodCeal™, the impacts of delays in direct heading. More recently, the potential benefits of new canola varieties with increased tolerance to shattering (Bayer's PODGUARD™ varieties) were also trialled.

GOA has previously presented and published on these topics, the detailed presentations and papers can be found on either the GRDC[1] or the GOA[2] website. This paper aims to try and summarise the key

[1] www.grdc.com.au
[2] www.grainorana.com.au

findings and to present a case for growers to reconsider how they might approach harvesting canola in the future.

What is the ideal windrowing time?

WRT is the stage of crop maturity when the crop is cut and placed into windrows to be later harvested when the grain has dried down to a deliverable moisture content (DMC) of 8%. The crop stage is identified by the percentage of the seed that is changing colour. For example, the currently accepted recommendation for the timing of canola windrowing is;

> 'Windrowing should commence when 40-60% seed in the middle third of the main stem has changed colour from green to brown, black or red.'(Carmody, 2009)

The recommendation states that it is the seed from the middle third of the main stem and any references in this paper to seed colour change (SCC) refers to this section of the crop.

The seed changing colour should be thought as an indicator of those seeds reaching physiological maturity. At this point seed has reached its full potential in terms of seed size and oil content. Prior to this point the seed is still growing (increasing in size) which is contributing to increasing yields and oil content. The recommendation of 40%-60% colour change infers that only 40-60% of the seed in the referenced part of the crop is mature and reached its full size, the remaining part of the crop is still growing. Any seed not mature at the time of windrowing will have any further growth or accumulation of oil stopped abruptly which will see potential further increases in yield or oil% forgone. The earlier the timing the more yield and oil% forgone, the later the timing the greater the potential yield that is realised.

However what also occurs with increasing levels of crop maturity is seed pods dry out and become increasingly brittle. Windrowing involves cutting the canola plant off at their stems and moving the the plant tops into a "windrow". This process can be aggressive and often results in pods impacting other pods/plants or parts of the windrowing machinery. This can break off and/or break open pods releasing the pods/seed onto the ground where they will not be captured by the harvester.

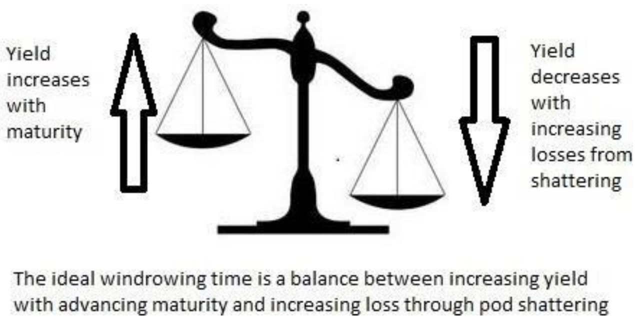

Figure 1: Illustration of the balance needed between increasing yields and increasing potential losses with advancing maturity.

An ideal windrowing time should be timed to maximise the increasing crop yield but not too late as to reduce harvestable yield by shattering out canola either before but more likely during the windrowing process.

So what did we find?

Large scale, replicated field trials run by GOA over three years showed that WRT could have an impact on oil% but it was often quite small and not significantly different. The effect of WRT on crop yield however was often much larger, not only in magnitude but economic impact. One of the first trials undertaken by GOA at Coonamble in 2009 showed that delaying WRT from 10% SCC to 70% SCC, or eight days increased by 500kg/ha. The increase represented a 30% yield improvement and at current canola prices[3] would be worth $250/ha.

More recently (2015, 2016 &2017) trials by NSW DPI under the GRDC co-funded "Optimised Canola Productivity" project, have looked more closely at the impact WRT can have on yields and oil%. This work has shown in some cases that yield impacts were even greater than those seen in GOA's trials. Yield increases of over 2T/ha were seen from the earliest WRT, <5% SCC, to the latest at 100% SCC at Tamworth in 2016. The influence of WRT on oil % was also much higher in these trials with increases of more than 7% resulting from delays in WRT (Graham et al, 2017).

The consistent message from both GOA and NSW DPI is that WRT earlier than the current recommended timings of 40-60% SCC, has universally resulted in significant yield penalties. Some of the most stark yield penalties from windrowing too early was seen in the NSW DPI trials at Trangie, Edgeroi and Tamworth in 2016 where reductions of 48%, 55% and 32% respectively were seen (Graham et al, 2016). Yield penalties from the larger scale field trials run by GOA which were commercially windrowed at the specific levels of SCC only ranged from 12-22% which are still significant losses.

The trials have also demonstrated the potential to increase yields further by delaying WRT past the recommended timings. The GOA trial at Coonamble showed a further 16% increase in yield (280kg/ha) from only a five day delay in WRT from 50% SCC to 70% SCC (Street, 2014). Delaying WRT at Trangie in 2016 from ~60% SCC to the 100% SCC increased yields by ~800kg/ha (Graham et al, 2017). A number of other trials also support these findings, where delaying WRT past 60% SCC tends to increase yields. This outcome is not unexpected given that up to 100% SCC some immature seeds within the crop are still developing and so could contribute to yield. The question remains however at what point do the losses from pod or seed shatter negate any further increases in yield?

How late is too late to windrow?

GOA undertook four trials that investigated the effects of delaying WRT past the current recommendations. These trials used commercial windrowers and headers and reported harvested yields. As such they take into account the potential losses from delayed windrowing. In these trials there was either increases in yields or trends to increase but no decline in harvested yields even where WRT was delayed up to 95% SCC. This is not to say that delayed WRT did not result in increased pod shattering, but any losses were compensated by increases in yields from other more immature parts of the plant.

As the NSW DPI trials were assessed by hand cuts from small plots, shattering seed loss from delayed WRT were not taken into account and the reported yields are somewhat theoretical. But given the lack of any measurable downturn in yields in the GOA trials with delays up to 95% SCC, the yield gains demonstrated in the NSW DPI trials might only be reduced by excessive pod shatter at the very late end of the range of WRT investigated.

This theory was confirmed by a GOA trial in Wellington, NSW where a measurable downturn in yield of 250kg/ha resulted from a delayed WRT. However the delay in was measured as 7 days after 100% SCC and so represented an extreme case of late windrowing.

When should I windrow?

The simple message from this work is that in the very least growers should strive to windrow at the current recommended timings of 40-60% SCC as significant yield and oil% penalties will occur by going earlier. However, there is a strong case to suggest growers should work to the later end of this range

[3] Assuming $500 ex farm (Newcastle port price less freight, November 2017)

of SCC or even beyond, if seasonal conditions are supportive of continued seed fill, as in many cases yields have increased further and there has been little evidence that increased pod shattering is resulting in any downturns in harvestable yields.

What is driving the later timing of windrowing?

Plant populations have generally reduced over the years. Street, 2014 first suggested that with lower plant populations proportionally less yield is carried by the main stem where we assess windrow timing. Crop maturity on branches is often behind that of the main stem and hence our current approach to assessing SCC on the main stem for windrowing was over estimating crop maturity as compared to crops with higher plant populations.

NSW DPI's more recent research with its increased precision has shown this to be true and are also suggesting assessing the whole plant for a measure of maturity rather than just the main stem.

Varieties have also evolved. Variety trials are often not windrowed but desiccated and direct headed. Varieties susceptible to pod shatter would suffer higher level of yield damage resulting in a yield handicap reducing the likelihood that any such varieties would progress to commercialisation.

This also means varieties of 20-30 years ago would have been more likely to shatter at earlier level of SCC tipping the scale towards an earlier windrowing time than it would be with today's varieties.

Where does direct heading fit?

Given that windrowing has the potential to reduce yields because it is done before all seed has matured, does direct heading have potential to capture higher yields? GOA ran four trials which have showed that yields from direct headed situations have generally matched the yields of a **well-timed** windrowing. If compared to that of an ill-timed windrowing i.e. too early or too late, the direct heading outperformed the windrowed treatment.

GRDC have produced a Direct Heading Factsheet[4] that examines many of the pros and cons of direct heading. The document suggests that on top of yield advantages, farmers should also consider the additional benefits including the elimination of windrowing costs, applicability for heavy lodged crops that cannot be windrowed and for lighter crops where small windrows may be unstable in windy conditions.

How does timing of harvest vary between direct headed or windrowed crops? And will desiccation help alleviate any differences?

One common concern for growers when considering direct heading is the perceived delay in the commencement of harvesting of direct headed cops. It is thought that compared to windrowed crops, ones left for direct heading take longer to dry down to acceptable grain moisture content before harvesting can commence.

One option to potentially manage this issue in direct headed crops is to apply a desiccant to the crop ahead of harvest to speed up the ripening process. Reglone™ has been registered for this purpose for some time but its cost, difficulties in application and perceived unreliability often deters many from its use.

More recently a glyphosate formulation, Weedmaster™ DST marketed by Nufarm has been registered for use in canola for pre-harvest application. While the main label claim is for pre-harvest weed control it also registered as a "harvest aid", suggesting that it may also speed up the ripening process.

Over three years GOA has run four trials investigating the relative effectiveness of Weedmaster™ DST and Reglone™, in reducing grain moisture content (GMC) to facilitate earlier harvesting. The key

[4] www.grdc.com.au/GRDC-FS-Direct-Heading-Canola

findings from this work was that Reglone, when applied as a desiccant to canola, showed some advantage in bringing GMC down quicker than natural ripening. At Wellington in 2013 the Reglone treatment would have allowed harvest to start approximately five days earlier. In the other locations the GMC of all treatments dropped below 8% within 2 days, hence the advantage of Reglone was much less or not even apparent as illustrated in Figure 2 below.

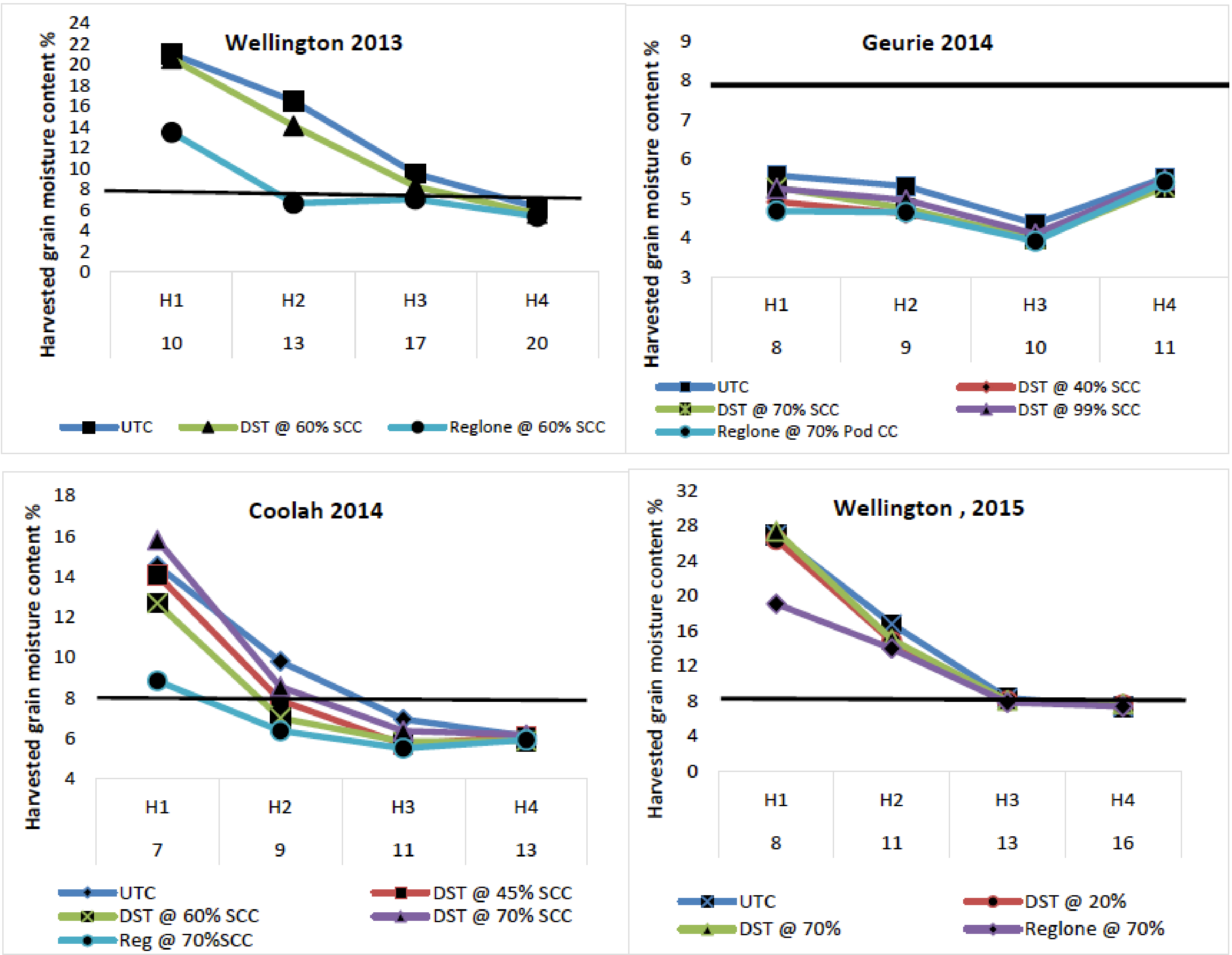

Figure 2: Harvested grain moisture contents in response to application of Reglone (REG) or Weedmaster DST (DST) at differing levels of seed colour change. As assessed at four different harvest timings (H1, H2, H3, H4). Numbers under the harvest timings indicate the number of days since the Reglone application (~70% SCC).

Weedmaster DST applied pre-harvest also showed little practical benefit at bringing harvest forward. Except for one DST treatment at Coolah in 2014 there was no significant difference in GMC at any harvest timing between any DST treatment and the untreated crop.

Further details of the trials can be found at

http://www.grainorana.com.au/documents?download=49

An interesting observation in these trials was the rate at which the crops ripened without any desiccation and the relevance this may have to potential time differences between harvesting of a windrowed crop and direct headed one. Reglone in the trials detailed above was applied at ~70% SCC and in light of recent research, this crop stage is arguably an acceptable windrowing time. It can be seen in the graphs above the time it takes the untreated crops to dry down the 8% GMC in relation to 70% SCC.

Both Wellington trials took only 13 or 17 days for the untreated to reach 8% moisture but in 2014, Geurie reached 8% moisture in under 8 days and Coolah within 10 days. Past experiences suggest windrows often cure for at least 10-14 days most years and so would suggest the time to harvest a direct headed crop would be within days of one that is windrowed and not weeks as often thought could be the case.

The view of longer delays to this may be brought about thought early windrowing. The earlier a crop is windrowed, the sooner it is dry enough to harvest relative to a crop left standing to ripen naturally. It could be suggested that in many cases if growers do experience lengthy delays in commencement of direct heading in comparison to similar ones around, it could indicate windrowing has commenced too early which we now know could be incurring significant yield penalties.

Windrowing allows me to get started on harvest earlier so as not to interfere with harvesting of my other crops

Many growers argue their preference for windrowing crops as it hastens harvesting however it is evidenced above, the difference may not be as large as some think if windrowing at the correct timings. That being said, windrowing may offer a number of days which may be useful but for many this may still not be enough. If growers choose windrow early to result in more available days to complete harvesting it should be remembered this could come at a significant cost. Numerous trials have shown that premature windrowing could be costing growers up to $50/ha/day.

Regardless of whether crops are windrowed at the more appropriate later timings or direct harvested, growers should consider changing the traditional harvest order. Canola does not always have to come off first.

Delayed direct heading and pod shattering

One GOA trial has shown that yields in direct headed crops can be relatively stable for a considerable period after the crop is ready to harvest. Results of a trial conducted in 2013, illustrated in Figure *3*, demonstrated that the yield did not decline for two weeks after the initial harvest timing. At this point there was a major weather event resulted in yield declines, after which the yields plateaued again, and this pattern recurred. This suggests that in this situation, yield decline when harvesting is delayed tends to be stepped rather than linear and that shattering yield losses are most likely a function of weather extremes, which are fortunately infrequent but unfortunately unpredictable in their nature.

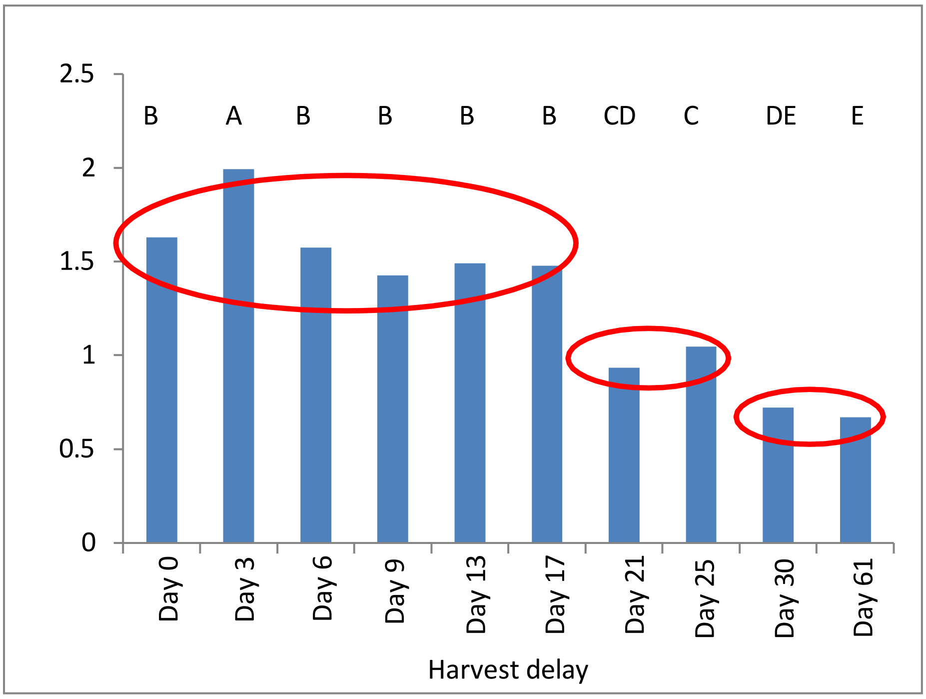

Figure 3: Harvested grain yields in response to delays in direct heading- Wellington 2013

PodGuard™ Canola Promises of Enhanced Shatter Tolerance

Recently Bayer has bred a unique genetic trait "PodGuard™" into selected new canola varieties offering increased tolerance to shattering. This trait may allow growers to either delay WRT until later stages of crop maturity to capture higher yields or allow growers to have confidence that crops left to direct head don't shatter before harvesting.

GOA in conjunction with Bayer tested shattering tolerance of PodGuard™ against in a non PodGuard™ variety in a trial conducted in 2015 A severe shattering event was simulated consisting of dragging a two inch steel pipe twice through the podding zone.

At the first harvest timing (H1) without the simulated shattering the yields of the two varieties are comparable. However, when the simulated shattering was applied only the yield of the variety 45Y25 was affected, reducing yields by around 600kg/ha. Delaying harvest by 14 days (H2) resulted in no statistically significant yield decline in the PodGuard™ variety however the yield of the 45Y25 was reduced by ~500kg/ha. Combining the simulated shattering event with the delay in harvest the 45Y25 suffered around a further 500kg/ha yield loss, while the PodGuard™ experienced no loss of yield, see Figure 4.

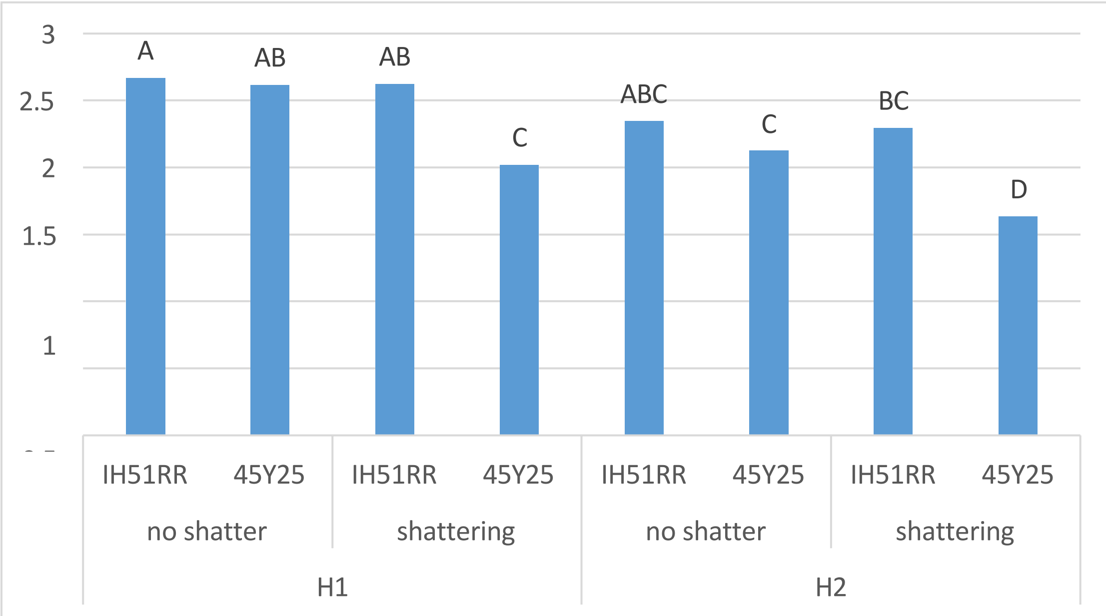

Figure 4: Harvested yield in response to harvest timing and simulated shattering by variety- Wellington 2015

During this trial measurements were made to quantify the source and timing of the losses encountered. Details of these are covered in the full trial report on the GOA website[5].

In summary the PodGuard™ variety IH51RR has shown good potential to resist shattering from delays in direct heading or shattering events such as high winds or hail. In the absence of such conditions non

Pulling it all together

Windrowing will remain popular with many growers for a number of reasons however growers should seriously consider windrowing toward the latter end of current recommended timings. There is mounting evidence to suggest that windrowing up to a conservative timing of 70-80% SCC can result in even further increases in yields and oils, as pod shattering at this crop stage is likely to be much less

[5] http://grainorana.com.au/documents?download=39

than current perceptions. Even if some shattering loss is apparent, it should be remembered that the increases in yields from the fuller maturation of the crop will often more than compensate.

Direct heading of canola is a worthy alternate to windrowing crops and much of the negative connotations of the past are not as common as often thought. Direct heading will allow for the whole crop to reach its full potential yield and oil%, and trial work suggests that it will yield as well as a correctly timed windrowed crop. If the alternate is to windrow too early or too late because of weather complications or availability of a windrower, direct heading may be the best.

Concern over rapid yield loss with delay to direct heading have not really been demonstrated in trial work or with commercial experience which has shown often yields to be quite stable post crop maturity. With ever improving varieties or PodGuard varieties, concerns could be even further allayed.

Time differences between windrowed and direct headed crops may also not be a different as thought provided windrowing of crops is done at more appropriate stages. If growers choose to windrow early to finish early, that decision will come at a significant price paid in terms of decreased yield and oil%.

An interesting consideration is that it has been shown that yield impacts from incorrect WRT to amount to losses of up to $50/ha/day, and that the rate of change in seed colour change can be very rapid. The opportunity to windrow is quite small, maybe as little as 1-3 days. In contrast the time to direct head a crop may be much longer.

GOA's trial work on desiccation products has shown little advantage in terms of closing the gap on harvest timing, with Reglone, while not consistent, performing better that Weedmaster DST but overall neither achieving practically useful results.

Useful resources

GRDC Grow Notes- Canola https://grdc.com.au/resources-and-publications/grownotes

Direct heading factsheet www.grdc.com.au/GRDC-FS-Direct-Heading-Canola

Canola best practice management guide for south-eastern Australia

https://grdc.com.au/resources-and-publications/all-publications/publications/2009/08/canola-best-practice-management-guide-for-southeastern-australia

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Lentil varieties for low rainfall and sandy soil environments

(SAGIT projects GGG118 & 121)

Lentil is the major pulse crop grown in South Australia (SA) and area continues to slowly expand in low rainfall regions. However, lentil varieties grown in low rainfall environments (LRE) of SA are generally the same as those grown in more favourable regions, despite evidence that variety performance varies from sandy to heavier textured soils. Furthermore, there has been little or no specific breeding and evaluation of lentil in LRE of SA prior to 2018.

Recently, progress towards the development of lentil varieties specifically suited to production in South Australia's low rainfall cropping regions has occurred. This has been due to advances being generated from South Australian Grains Industry Trust (SAGIT)-funded projects started in 2018 and led by Global Grain Genetics (GGG) the research arm of the private plant breeding company Grains Innovation Australia (GIA).

These projects aimed to identify the key traits required for lentil production in low rainfall areas and develop innovative lentil germplasm with improved and unique traits for SA's low rainfall cropping regions.

Lentil evaluation and breeding trials were located across low rainfall and sandy soil environments of SA, including the mallee, upper Yorke Peninsula and the Eyre Peninsula from 2018. Key findings from these research trials have included:

- Summer plus growing season rainfall (Nov.-Oct.) is more important than summer or growing season rainfall alone to lentil production in low rainfall environments (LRE). Growers can use summer rainfall totals to guide lentil sowing plans and help to manage production risks of lentil in LRE.
- A positive relationship between plant biomass pre-flowering and grain yield in lentils in LRE. Lentil growers in LRE should place a significant focus on early sowing, good seed, establishment, early biomass production and limiting plant stress (eg herbicide damage) and weed competition to maximise yields.

Table 1: Relationship between mean grain yield and mean plant dry matter, 10 weeks after sowing and early flowering, in lentil at six LRE sites in SA and Vic. in 2018 and 2019.

Variety/line	Targeted grain Yield (t/ha)	Mean dry matter - 10 Weeks After Sowing (t/ha)	Mean dry matter - early flowering (t/ha)
R^2 (Grain yield)	-	0.52	0.85
F pr. (Grain yield)	-	0.03	<.001
Equation (Grain yield)	-	Y=0.212X+0.053	Y=1.215X+0.247
Estimated dry matter (t/ha) required for targeted grain yields (0.5, 1 & 2 t/ha)	0.5	0.16	0.82
	1	0.27	1.45
	2	0.48	2.73

- Conventional lentil variety PBA Jumbo2 was the highest yielding variety across all years and trials but had lower relative yields on the heavier textured soils compared to the deeper sandier soils.
- Two IMI tolerant recently released varieties from Grains Innovation Australia, GIA Thunder & GIA Lightning, were 14 and 8% higher yielding than PBA Jumbo2 respectively, across all LRE trials from 2019-21, and both averaged approximately 10% higher yielding than all commercial lentil varieties and PBA breeding lines in NVT in Australia in 2020 and 21.
- Specifically, the SAGIT funded trials showed that GIA Lightning was the most reliable lentil variety on lighter textured sandy soils due to its combination of high and stable yield, and good harvestability, yielding 10% higher than GIA Thunder. GIA Lightning was found to have a unique extended growth pattern during flowering and early podding that can capitalise on late season rainfall events on these soils.
- Breeding lines derived from the highly disease resistant PBA Jumbo2 through direct selection in the SA mallee were up to 12% higher yielding than PBA Jumbo2 across all low rainfall evaluation trials in 2020 and 21. These lines are being further evaluated for possible future varietal release.
- The traits of early vigour, multiple herbicide tolerances (Group B + C + soil residual I), increased plant biomass and higher harvestable height were identified as important to successful lentil production in LRE and have been incorporated into breeding lines by GIA for further evaluation.
- Varietal lentil mixes with contrasting phenology were assessed in 2021 as a way of mitigating the impact of environmental stresses of the low rainfall regions such as frost, high temperature events and transient drought. The results from 2021 were variable with the average yield of the GIA Thunder/GIA Lightning mix lower than its components and the GIA Leader/PBA Hallmark XT/PBA Highland XT mix slightly higher than its component yields across all sites. Further evaluation of this concept is occurring in 2022.
- The development of novel glass house screening tests for tolerance to soil texture and Group C herbicides in lentil have been developed and is allowing for the rapid incorporation of these traits into elite breeding lines.
- In 2021, 100 lentil breeding lines, commercial lentil varieties and alternative pulses, were screened in a mallee sand (high sand content) and commercial potting mix in a polyhouse. No lentil breeding line, vetch or field pea had a higher seedling weight than the control variety PBA Jumbo2 in the Mallee sand, but the chickpea and faba bean had significantly greater seedling weight than this variety. A few lentil lines and the chickpea had a lower reduction in plant dry weight than PBA Jumbo2 in the Mallee sand compared to the potting mix. The chickpea finding may explain why many northern mallee growers prefer this crop over lentil on the sandy mallee soils.

In 2022, SAGIT funded lentil breeding trials are being conducted at four low rainfall sandy soil textured sites and one heavy textured comparator site. These trials are evaluating advanced GIA breeding lines that incorporate multiple adaptive low rainfall traits with the aim of identifying varieties that improve the reliability of lentil production in low rainfall sandy textured soil environments of SA.

Acknowledgements SAGIT GGG118/121 for funding the project, Michael Moodie-Frontier Agronomy, Sam Trengove-Trengove Consulting, Andrew Ware-EPAG Research for trial management assistance. Grower co-operators: Wade and Chad Nickolls (Pinnaroo), Trengove family (Bute), Kate and Grant Wilson (Hopetoun), Basil and Andrew Heath (Murdinga), Robin Schafer & Andrew Biele (Loxton), Travis and Nathan Flight (Nangari), Peter Blair (Horsham).

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Preharvest sprouting in wheat

Daryl Mares, University of Adelaide

- Preharvest sprouting – germination of grain in the field prior to harvest in response to rain.

- Current wheat varieties have only limited or no resistance to sprouting at harvest-ripeness. Most are rated in the range from moderately resistant to very susceptible.

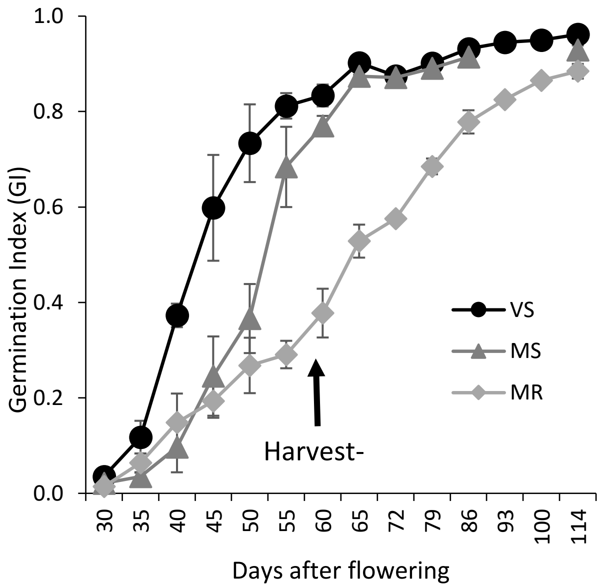
- Wheat grains of current varieties acquire the capacity to germinate prior to harvest-ripeness and as ripening progresses, the rate at which the grains will germinate increases.

- Overall, for crops at harvest-ripeness, the grain will need to stay moist for around 2 – 3 days although this time will decrease the longer harvest is delayed. The length of time the grain remains wet enough to germinate will depend on the amount of rain, the duration of the rain, temperature, humidity and wind.

- The rate at which grains will germinate continues to increase after harvest-ripeness. Prompt harvest is therefore critical if unfavourable weather is predicted.

- Rainfall prior to harvest-ripeness – rain (more than 20 mm) during the 10-20 days prior to harvest-ripeness often results in little or no sprouting but may predispose the crop to be more susceptible to later rainfall.

- Grain that has started to germinate may lose viability during storage if the grain is being held on farm for next season's crop. A germination test is therefore recommended prior to sowing (see GRDC Retaining seed fact sheet).



Germination Index (GI) – based on daily counts of germinated grains in germination tests run for 7 days.

Low GI – a small percent of grains germinate very slowly

High GI – a high percent of grains germinate within 2 days

VS – very susceptible, MS – moderately susceptible, MR – moderately resistant

Image and further text to be found at:

https://grdc.com.au/resources-and-publications/all-publications/factsheets/2021/grdc-fs-retainingseed

Additional points:

- Grains affected by black point are more prone to sprouting.
- Sprouting is the major, but not the only, cause of low Falling Number.
- Low Falling Number grain should not be mixed with high Falling number grain.
- In addition to sprouting, repeated rain events cause a progressive reduction in Test Weight.