Re-evaluating seed colour change in canola to improve harvest management decisions – Tamworth 2016

Rick Graham, Rod Bambach, Jan Hosking, Stephen Morphett, Michael Dal Santo and Jim Perfrement
NSW DPI, Tamworth

Key findings

- Seed colour change (SCC) is slower to develop on branches compared with primary stems, with the primary stem only contributing ~22% of grain yield.
- Relying solely on SCC on the primary stem can underestimate overall seed development on the plant, negatively affecting seed size, oil concentration and yield potential.
- Windrowing earlier than 40% SCC on the primary stem was shown to reduce yield by up to 36% and oil concentration by 6.5%.
- Results clearly demonstrated the penalties associated with an early windrow timing, before 40–60% SCC on the primary stem, and the benefit of delayed windrow timings related to SCC, with yield optimised at the upper end of current industry guidelines.
- Ideally, SCC should be measured on a whole plant basis, not based solely on the primary stem, as branches contribute a large proportion of grain yield. There is also a further need for a clear definition as to what constitutes actual SCC in order to develop robust industry guidelines around windrow timing.

Introduction

Due to the increased prevalence of hybrid canola varieties, lower plant populations and perceived changes in plant architecture, there has been increased discussion in the canola industry about how best to determine seed colour change (SCC) and therefore windrow timing. Current industry guidelines, based on research conducted in the 1970s and 1980s, recommend that canola (*Brassica napus* L.) is ready to windrow when 40–60% of seeds on the primary (main) stem change colour from green to red, brown or black. The main issue of concern with this recommendation relates to the proportion of yield contained on the branches versus the primary stems, and the effect of the differential rate of seed maturity on yield and seed quality parameters.

In 2015, research started as a component of the GRDC co-funded 'Optimised canola profitability' project (CSP00187), to examine the relationship between SCC, grain yield and quality parameters, which aims to help growers make better informed decisions on canola harvest management in northern NSW, and potentially across Australia. These preliminary results indicated that there were large effects of where on the plant (branch vs. primary stem) SCC was measured. It was subsequently found from partitioning seed from pods that branches were slower to mature than the primary stems and that there was potential for significant yield and grain quality reductions associated with windrow timing. In 2016, a further series of experiments were conducted in the northern grains region (NGR) of NSW; findings from an experiment conducted at Tamworth in 2016 are outlined in this reported.

Site details

Location	Tamworth Agricultural Institute
Soil type	Grey vertosol
Previous crop	Barley
Starting soil water	~60 mm PAW to 120 cm
In-crop rainfall	~524 mm (May to October)
Starting nitrogen	Soil nitrate N was ~58 kg N/ha (0–120 cm)
Trial design	A replicated split plot design was used, with windrow timing as the main plot and variety randomised within the treatment timing plots.

Fertiliser	60 kg/ha Granulock Z Extra treated with Intake® (500 g/L Flutriafol at 200 mL/ha) and 360 kg/ha urea (160 kg N/ha) side banded at planting.
Sowing date (SD)	6 May 2016
Plant population	~30 plants/m^2

Treatments

Varieties (2)

Pioneer® 44Y89 (CL), Hyola® 575CL

Windrow timing

Windrow timings were conducted at 2–3 day intervals (i.e. Monday, Wednesday and Friday) from the start of SCC on the primary stem up until 100% SCC on branches. SCC was defined as when 'a minimum of two-thirds of the surface area of an individual seed changed colour from green to brown, red or black'. Actual SCC was determined using a representative 200 seed sub-sample, taken from pods from the middle third of the primary stem and randomly from across the branches of individual plants.

Results

Results focus on the overall effect of windrow timing and SCC on grain yield and oil concentration, rather than on varietal differences. It is, however, important to note that there were varietal differences that did influence the rate of seed development which, in turn, would influence management decisions around windrow timing. Both Pioneer® 44Y89 (CL) and Hyola® 575CL reached 50% flowering (i.e. ~50% plants with one flower open on the main stem) on 16 August. There were differences in how the varieties progressed from flowering to maturity, with Pioneer® 44Y89 (CL) faster to mature than Hyola® 575CL. Pioneer® 44Y89 (CL) reaching the end of flowering (5% flowers remaining) five days quicker than Hyola® 575CL (22 September vs. 27 September). As a result, SCC at any target timing for Pioneer® 44Y89 (CL) was more advanced and progressed more rapidly than Hyola® 575CL.

Seed colour change (SCC)

SCC and therefore, windrow timing treatments, started on 14 October at Tamworth in 2016. SCC was found to develop faster on the primary stem compared with branches. When looking at windrow timing averaged across the two varieties, it was observed that when SCC on the stems was at 61%, branches were only at ~20% SCC (windrow timing 7; Figure 1). These results also highlight how rapidly SCC can occur, with SCC on stems progressing from 18% to 61% at Tamworth in a 5-day period (windrow timing 5–7), in what was considered a very soft spring (Figure 1).

Seed size

Seed size, expressed as thousand seed weight (TSW), is an indicator of both physiological maturity and yield potential. When looking at changes in TSW over time at Tamworth (Figure 2) in relation to windrow timing, it was observed that differences in TSW stems *vs*. branches were largest during the earlier windrow timings reflecting differences in SCC and maturity. This would be expected given that seeds mature progressively up the primary stem from the lower branches to the upper branches, with changes in seed colour indicating declining metabolic activity and increasing seed maturity. At Tamworth in 2016, TSW for the branches and stems tended to plateau at ~60% SCC, which approximated 35% moisture content. Importantly, the optimum TSW for branches occurred with windrow timings later than current industry recommendations, which are based solely on SCC for the primary stem. This is significant given that branches contributed 78% of potential yield at Tamworth averaged across varieties.

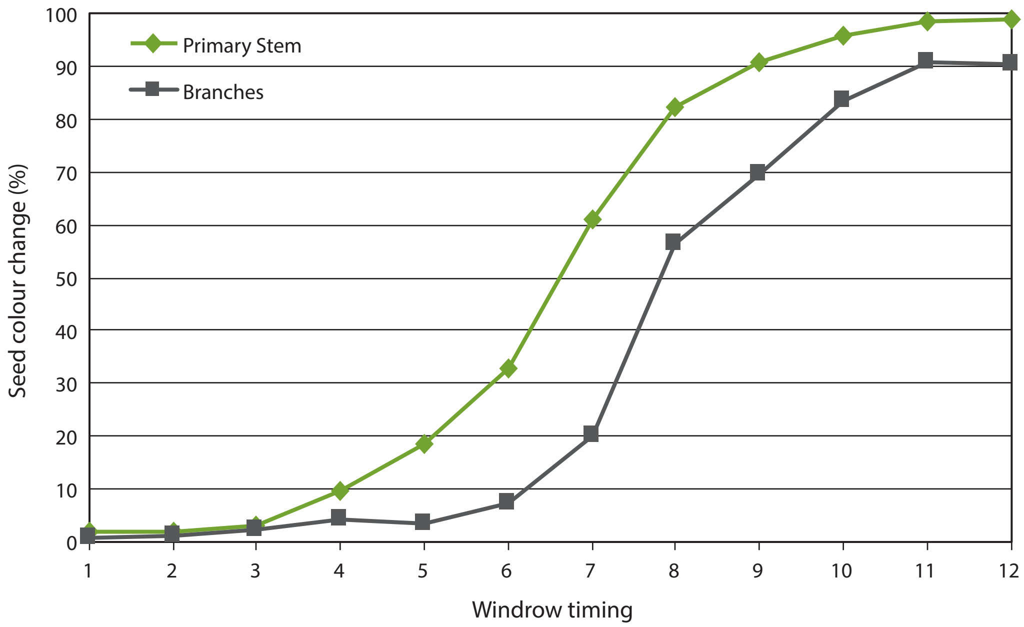

Figure 1. Seed colour change (%) primary stem vs. branches over time as determined by windrow timings at Tamworth in 2016. l.s.d. ($P = 0.05$) for primary stem = 14.2 % and l.s.d. ($P = 0.05$) for branches = 10.9 %.

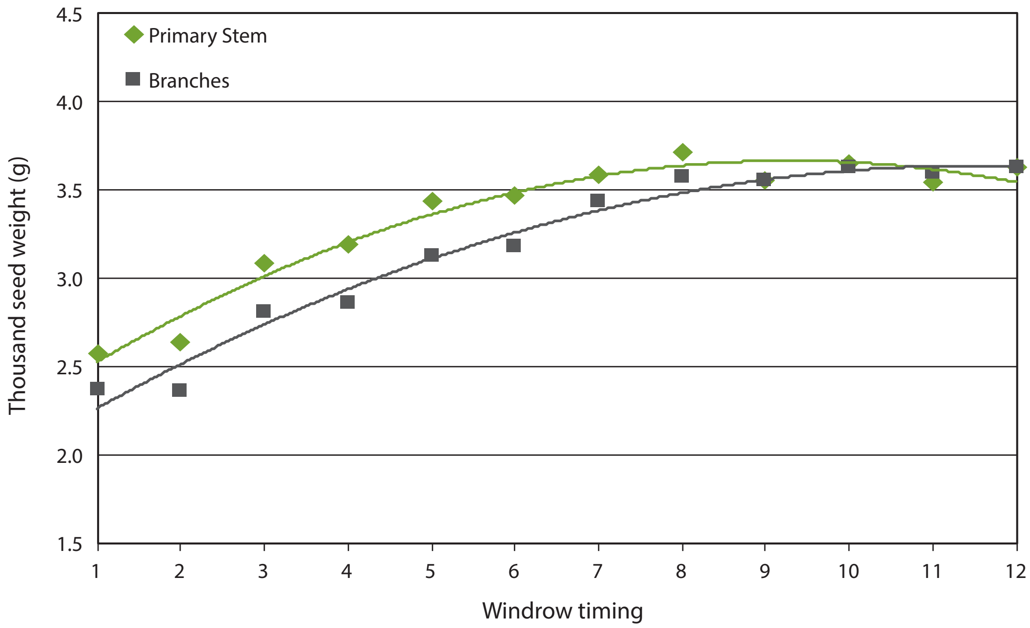

Figure 2. Changes in seed size (TSW) primary stem vs. branches over time as determined by windrow timing for Tamworth in 2016. l.s.d. ($P = 0.05$) for primary stem = 0.19 g and l.s.d. ($P = 0.05$) for branches = 0.15 g.

Grain yield

Windrowing when SCC started at Tamworth (timing 1) resulted in a 1.42 t/ha decline in yield potential, compared with windrowing at ~40–60% SCC on the primary stem (timings 6–7), which equates to a yield loss of ~36% (Figure 3). When considering the breakdown of yield components – primary stems *vs.* branches – it was observed that stems only contributed 22% of total grain yield averaged across windrow timings (data not shown). As was noted with SCC, seed sampled from the branches was less advanced than the primary stem, taking longer to reach physiological maturity. Grain size (TSW) for the branches plateaued at approximately 60% SCC (~timing 8) equating to a yield increase of ~0.20 t/ha or 5% over windrow timings 6 or 7.

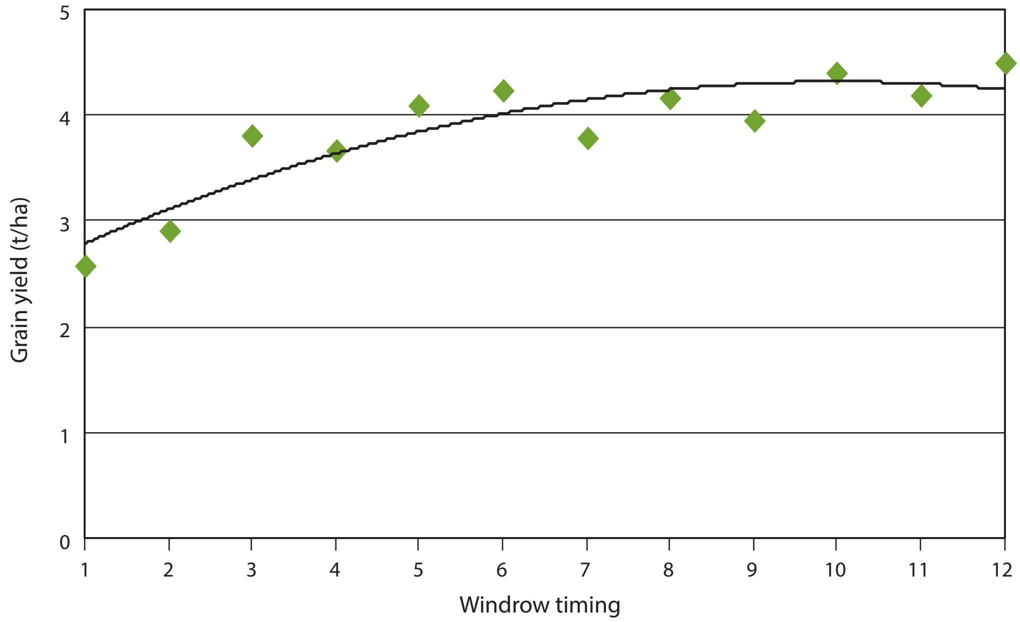

Figure 3. Effect of windrow timing/seed colour change on grain yield (t/ha) at Tamworth in 2016. l.s.d. ($P = 0.05$) = 0.54 t/ha.

Oil concentration

As per the grain yield response, there were significant oil concentration penalties for windrowing at early stages of SCC. At Tamworth, there was a 14% decline, or a 6.5% reduction in oil concentration (38.9% vs. 45.4%) when windrowing as SCC started versus windrowing at ~40% SCC on primary stems. There was also an increase in oil concentration where SCC was >60% on the primary stem, with increases in oil concentration of 0.6–2.0% (Figure 4).

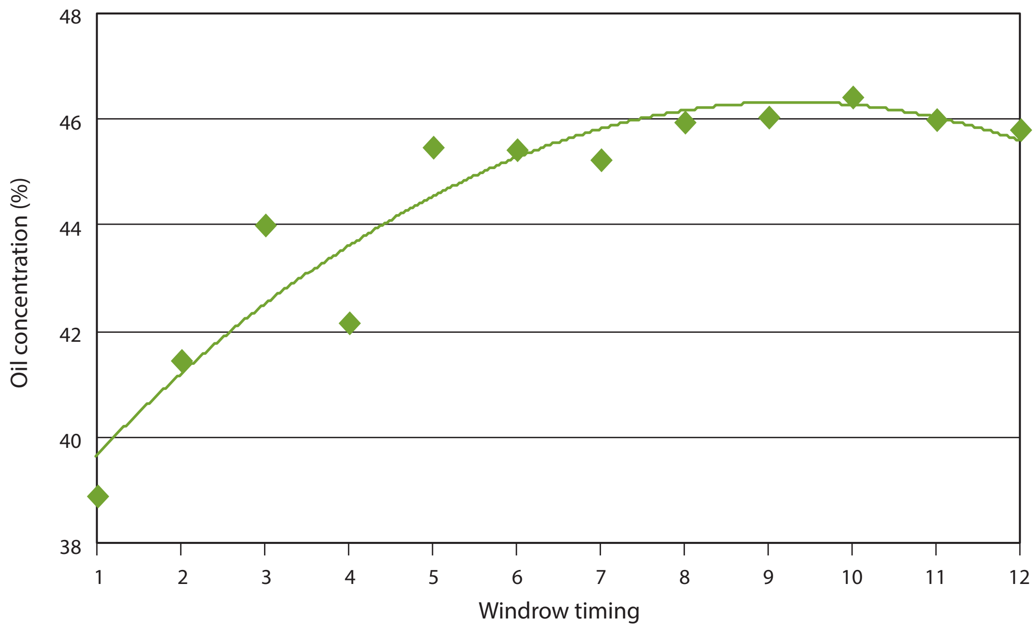

Figure 4. Effect of windrow timing/seed colour change on oil concentration (%) at Tamworth in 2016. l.s.d. ($P = 0.05$) = 0.57%.

Conclusions

Results from this experiment, underline the importance of correct windrow timing and the need to accurately determine SCC. It was observed, from partitioning seed from pods on the primary stem and branches that SCC was slower to develop on branches compared with stems. Importantly, in the yield components breakdown, it was found that seed from the primary stem only contributed ~22% of grain yield at Tamworth in 2016. If SCC on the primary stem is solely relied upon for windrowing decisions, overall seed development can be underestimated.

This can negatively affect seed size, oil concentration and yield potential. Furthermore, windrowing earlier than 40% SCC was shown to significantly reduce yield – by up to 36% and oil concentration by 6.5%.

Results clearly demonstrate the penalties associated with the current recommendation of early windrow timing at 40–60% SCC on the primary stem, and the benefit of delayed windrow timings related to SCC, with yield optimised at the upper end of current industry guidelines. Given the significance of the yield component contributed by the branches as opposed to stems, and with the increasing prevalence of hybrid varieties, lower plant populations, and associated changes in plant architecture, there would appear to be a need to reconsider the method of how SCC is determined.

This study demonstrates that SCC should ideally be measured on a whole plant basis and not solely on the primary stem. There is also a further need for a clear definition as to what constitutes actual SCC in order to develop robust industry guidelines around windrow timing.

Acknowledgements

This experiment was part of the project *Optimised canola profitability* (CSP00187), with joint investment by NSW DPI and GRDC, which is a collaborative project between NSW DPI, CSIRO and GRDC, in partnership with SARDI, CSU, MSF and BCG. Rohan Brill from NSW DPI is gratefully acknowledged for experiment design and for developing the research questions, technical guidance and protocol development; Dr Neroli Graham is thanked for biometric support.