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

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Abstract

Industry guidelines for windrowing of canola recommend that optimum cutting time occurs when 40–60% of seeds on the primary stem have changed colour from green to red, brown or black. Due to the increased prevalence of hybrid canola varieties, lower plant populations and perceived changes in plant architecture there has been increased discussion on how best to determine seed colour change (SCC) and therefore windrow timing. In 2016, experiments were conducted at three sites in northern NSW, to investigate the effect of SCC and windrow timing on seed size, oil concentration and seed yield. It was observed, from the partitioning of seed from pods on the primary stem and branches that SCC occurred later on branches compared to stems. Importantly, in the breakdown of yield components, it was found that seed from the primary stem only contributed 22% to 37% of seed yield. If SCC on the primary stem is solely relied upon for windrowing decisions overall seed development can be underestimated. This will negatively impact on seed size, oil concentration and yield potential. Furthermore, windrowing earlier than 40% SCC was shown to significantly reduce yield by up to 55% 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. This study indicates that SCC should be measured on a whole plant basis not based solely on the primary stem, as branches contribute a large proportion of seed yield.

Keywords

Windrow timing, seed size, seed yield, oil concentration.

Introduction

Current Australian industry guidelines based on research conducted in the 1970's and 1980's and supported by Hocking and Mason (1993), recommend that canola (*Brassica napus* L.) should be windrowed when 40–60% of seeds on the primary or main stem (primary racemes) change colour from green to red, brown or black. In the past decade with the introduction of hybrid varieties and associated changes around farming practices, there has been increased discussion about how best to determine SCC (Street, 2014) with a call for further research into windrow timing, particularly in central west and northern NSW (Hertel 2013). The main concerns relate to the proportion of yield contained on the branches (secondary racemes) versus the primary stems and the effect of the differential rate of seed maturity on yield and seed quality parameters.

In 2015 research commenced as a component of the GRDC co-funded 'Optimised Canola Profitability' project (CSP00187), to examine the relationship between SCC, seed yield and quality parameters, with the aim of assisting growers to make more informed decisions on canola harvest management in the northern NSW, and potentially across Australia. Initial results outlined by Graham et al. (2016) found there were large differences in SCC depending where on the plant (branch vs. primary stem) SCC was measured. It was subsequently found from the partitioning of seed from pods (siliques), that branches were slower to mature than the primary stems and that there was potential for significant yield and seed quality reductions associated with windrow timing, related to this differential seed development. A series of experiments were conducted in 2016, to further investigate the effect of SCC and windrow timing on canola seed size, seed yield and oil concentration; findings from these experiments are reported in this paper.

Methods

Experiments were conducted at sites located at 'Tarlee' Edgeroi on the North West plains of NSW, Tamworth Agricultural Institute in North West NSW and Trangie Agricultural Research Centre in the

Central West of NSW in 2016. A replicated split plot design was used in each experiment, with windrow timing as the main or split plot and variety randomised within the treatment windrow timing plots. Individual experiments were analysed spatially using Genstat 18th edition (VSN International 2015). Experiments were sown on the 6th May at Tamworth and Trangie, and the 10th May at Edgeroi and were managed using best management practices to limit biotic stresses and nutritional constraints. The hybrid canola varieties Pioneer® 44Y89 (CL) and Hyola® 575CL, with similar flowering times but different maturity ratings, were sown in experiments conducted at Tamworth and Trangie, whilst Pioneer® 44Y87 was sown at Edgeroi.
Windrow timings were conducted at 2-3 day intervals (i.e. Monday, Wednesday and Friday) from the commencement of SCC on the primary stem up until 100% SCC on branches. For consistency across experiments, 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. Yield and seed quality components, were determined by threshing 3 x 1 m hand-cuts taken from the middle rows at either end of experimental plots. Six plants sampled from the middle rows, three from each end of a plot, were also threshed to determine the proportion of yield from branch and stems, with seed moisture percentage and thousand seed weight (TSW) at actual SCC and SCC for yield components (stem vs. branches) recorded. Seed quality parameters measured included oil concentration recorded at 6% moisture , determined by near-infrared spectroscopy with an Infratec® 1241 Grain Analyser.

Results

Results focus on the overall effect of windrow timing and SCC on seed yield and oil concentration, rather than on varietal differences.

Seed Colour Change (SCC)

SCC and hence windrow timing treatments commenced on the 4th October at Edgeroi, 7th October at Trangie and the 14th October at Tamworth. SCC occurred earlier on the primary stems compared to the branches. When looking at windrow timing averaged across the two varieties at Tamworth, it was observed that when SCC on the stems was at 61%, branches were only at 20% SCC (Windrow Timing 7, Figure 1). Similarly at Edgeroi and Trangie where SCC was more rapid, the stems were more advanced than branches at key windrow timings. At Trangie for example, when the stems were at 84% SCC (Windrow Timing 7), branches were only at 43% SCC, likewise at Edgeroi when stems were at 80% SCC, branches were at 52% SCC (data not shown). These results further highlight how rapid SCC can occur, with SCC on stems advancing from 18% to 61% at Tamworth in a 5 day period (Figure 1).

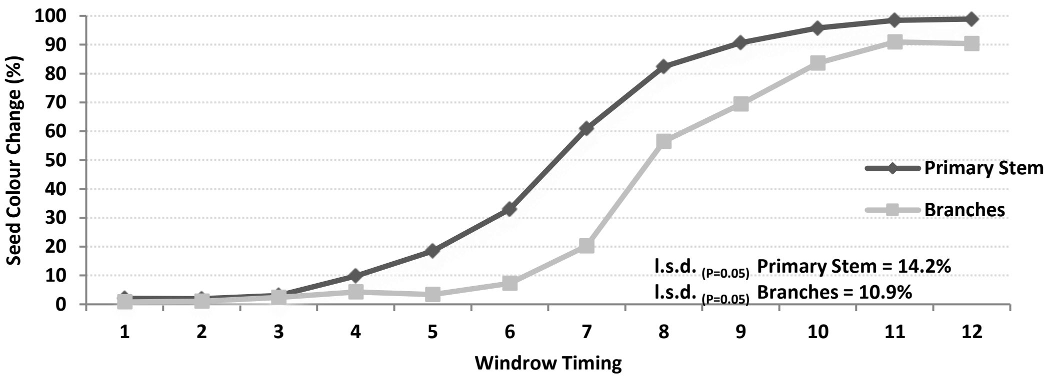

Figure 1. Seed colour change (%) primary stem vs. branches over time as determined by windrow timing timings at Tamworth in 2016.

Seed size

Seed size expressed as TSW is an indicator of both physiological maturity and yield potential. When looking at changes in TSW over time at Tamworth (Figure 2a) and Trangie (Figure 2b), as determined by windrow timing, it was observed that differences in TSW stems *vs*. branches were largest during the earlier windrow timings reflecting differences in SCC and hence maturity. This would be expected given that seeds mature progressively up the primary stem and from the lower branches to the upper branches, with changes in seed colour indicating declining metabolic activity and increasing seed maturity (Hertel 2012). At Tamworth TSW for the branches and stems tended to plateau at ~ 60% SCC, which approximated 35% moisture content. Importantly, the optimum TSW for branches occurred at a later stage of windrow timing, than current industry recommendations based solely on SCC for the primary stem. This is of significance given that branches contributed 78% of potential yield at Tamworth. A similar pattern of TSW development on branches vs. stems was also observed at Edgeroi (data not shown).

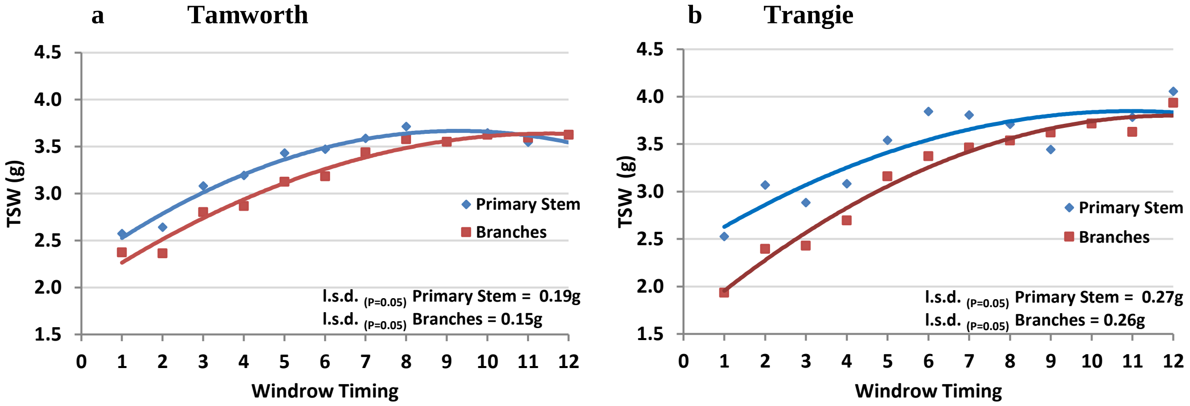

Figure 2. Changes in seed size (TSW) primary stem vs. branches over time as determined by windrow timing for Tamworth (a) and Trangie (b) in 2016.

Seed Yield

Windrowing at the commencement of SCC at Trangie (Timing 1 SCC ~6% on primary stem) resulted in a 1.06 t/ha to 1.34 t/ha decline in yield potential, compared to windrowing at 40% to 60% SCC on the primary stem (Timings 4-6), equating to a yield loss of 42% to 48% (Figure 3). When looking at the breakdown of yield components primary stems *vs.* branches, it was observed that stems only contributed 37% of total seed yield at Trangie, 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. Seed size (TSW) plateaued at approximately 60% SCC (~Timing 8) equating to a yield increase of 0.61 t/ha or 17% over Timing 6 (data not shown). At Edgeroi, seed yield based on 40-60% SCC on the primary stem, ranged from 1.70 to 2.35 t/ha respectively, with yield peaking at 2.42 t/ha, SCC on branches at 65%. The yield penalty at Edgeroi for windrowing at the commencement of SCC (~ 6% SCC on primary stem) vs. industry guidelines (40-60% SCC primary stem) was 0.6 to 1.3 t/ha, equating to a potential yield decrease of up to 55% (data not shown). At Tamworth, the penalty for early windrowing at the commencement of SCC versus industry recommendations was 1.20 t/ha, a potential yield loss of 32% (data not shown). In all three experiments delaying windrow timing to where SCC on the primary stem was >60% either resulted in significant (P<0.001) increases in yield (i.e. Edgeroi and Trangie), or trended towards increased yield at Tamworth.

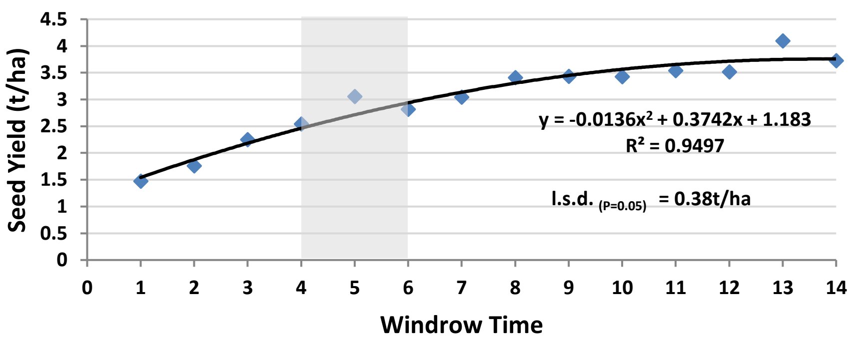

Figure 3. Effect of windrow timing/seed colour change on seed yield (t/ha) at Trangie in 2016. Shaded area approximates windrowing at 40% to 60% SCC on the primary stem (Timings 4-6).

Oil concentration

There were significant (P≤ 0.001) oil concentration penalties for windrowing at early stages of SCC. At Tamworth, there was a 14% decline, a 6.5% reduction in oil concentration (38.9% vs. 45.4%) for commencement of SCC versus ~40% SCC on primary stems. There was also an increase in oil concentration at Tamworth where SCC was >60% on the primary stem, with increases in oil concentration of 0.6 to 2.0%.

At Edgeroi there was a significant (P=0.001) decrease in oil concentration with early versus >40% SCC on the primary stem with oil concentration declining by 3.9% (Figure 4). Similarly at Trangie, there was a significant (P<0.001) decline in oil concentration of 4% (early versus >40% SSC), whilst there was an increases of 1.1% to 1.9% in oil concentration, with delayed windrow timings of >60% SCC (data not shown).

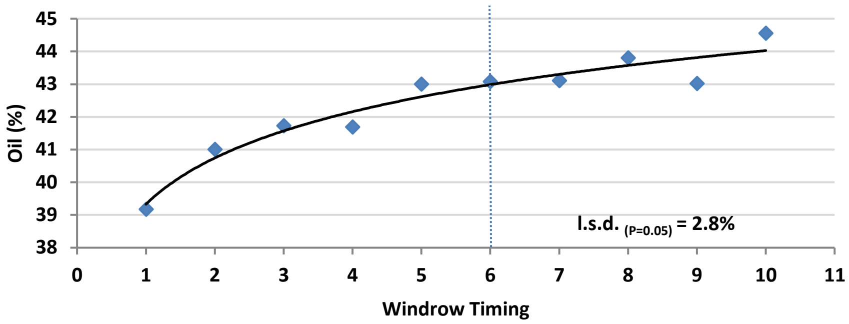

Figure 4. Effect of windrow timing on canola seed oil concentration at Edgeroi in 2016 (windrow timing 6 approximating 40% SCC on the primary stem).

Conclusion

This study demonstrated that relying exclusively on seed from the primary stem to predict SCC and windrow timing in canola, underestimates overall seed development across the whole plant, and negatively impact on seed size, oil concentration and yield potential. It was observed from the partitioning of seed from the primary stem and branches that SCC occurred later on branches compared to primary stems due to the later maturity of seed on the branches. This is of significance, when you consider the breakdown of yield components of primary stems vs. branches, where seed from primary stems were found to only contribute 22% to 37% of total seed yield averaged across windrow timings at experiments conducted at Trangie and Tamworth respectively. TSW, oil concentration and yield all increased when delaying windrow timing until later than the currently recommended SCC guidelines of 40-60 %. At the other extreme, windrowing earlier than 40% SCC on the primary stem, at the commencement of SCC, resulted in significant reductions in yield and oil concentration at all sites, with the largest impacts being a yield decline of 55% at Edgeroi, and oil concentration declining by 6.5% at Tamworth. These findings indicate that SCC should be measured on a whole plant basis, not only the primary stem, particularly as seed from branches contribute a large proportion of seed yield. This study clearly demonstrates the penalties associated with early windrow timing and the benefits of delayed windrow timings related to SCC, with yield optimised at the higher end of current industry guidelines (i.e. ~60% SCC).

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