SE Australia Survey Report (2009 – 2012)

Windrowing Canola: Practices, perceptions, knowledge & understanding

Key points

- Industry published guidelines recommend windrowing canola when 40–60% of seed on the main stem has changed colour, to optimise yield and oil content. Only fifty respondents out of 900 (5.5%) nominated this timing as the optimum.
- 'Colour change' means different things to different people. Understanding the term 'colour change' is crucial to avoid potentially significant production and economic penalties. Colour change is when the seed coat has changed from green, darkening to red, brown or black. Colour change is NOT when there are flecks or spots of brown on the green seed.
- For the most part, descriptions of how crops are assessed to determine the optimum time for windrowing were very vague. For example, where to examine the plant canopy; bottom, middle or higher canopy, main stem vs branches.
- The effect of windrow timing on the degree of oil penalty was a major concern. However, the majority of individuals had little confidence in the accuracy of their estimations.
- The majority of individuals commented that oil accumulation occurred during late seed development, but the perception of when "late" actually was and the amount of oil, was inconsistent.
- Impacts of windrow timing on yield in the absence of shattering were poorly understood.
- The level of knowledge and understanding of plant growth and development across the canola industry was mixed. Improving knowledge and understanding of plant growth and development will allow observations in the paddock to be used to make informed practical and economic harvest management decisions.
- Overall there was no significant difference between industry groups or an individual's experience in their knowledge and understanding of canola growth and development during late crop maturation.

Introduction

Windrowing canola has long been regarded as a standard operation in canola production. The expansion of canola production into more marginal areas, larger crop areas, the increasing frequency of below-average and variable seasonal conditions and a closer focus on the economics of all facets of crop production have contributed to greater interest in direct heading crops and discussions surrounding canola harvest management.

Determining when (or if) a crop should be windrowed is often the result of the input from different persons. These may include growers, agronomists and contractors, and often all three. Frequently, the opinion of individuals varies considerably, creating confusion when conflicting viewpoints are strongly expressed. These differences may be reflected in the decisions as to when to commence windrowing.

The breadth of size of the range of these views and their perceived potential impacts on economic outcomes was unknown. This paper reports on the findings of a survey conducted in canola growing areas in NSW, Victoria and South Australia over 3 years (2009, 2011 and 2012) to determine views and knowledge that underpin windrowing and broader harvest management practices.

Aims of the survey

The survey aimed to determine:

1. the current skills and practices used to determine the optimum timing of windrowing,
2. levels of technical knowledge and understanding of canola growth and development and;
3. attitudes regarding the role of windrowing and its associated risks.

How the survey was carried out

The survey consisted of two main components:

1. A telephone survey of 140 industry participants across NSW. It included specific open and closed questions. This approach encouraged wide ranging discussions and allowed a diversity of information, both qualitative and quantitative to be gathered.

   The telephone survey took place during 2011 over a five month period. It involved telephoning people across all canola growing areas of NSW. Individual surveys / conversations varied between 12 and 75 minutes with the overall survey totalling 52 hours. Of the total of 140 people surveyed, 60 were growers, 60 agronomists and 20 were windrowing contractors.

2. A modified version of the telephone survey was carried out at 26 field days, workshops, and agronomy updates, totalling 1042 participants in NSW, Victoria and South Australia.

The following findings are from 900 respondents who reported some experience with canola. Responses from participants who had not worked with canola were removed from the final compilation and analysis. The results were analysed with statistical simulations to determine the probability in a Chi-square test of independence.

At times some questions were not answered.

Results

Figure 1 shows the category breakdown of the 900 respondents. Participants were asked to nominate their main role in the canola industry.

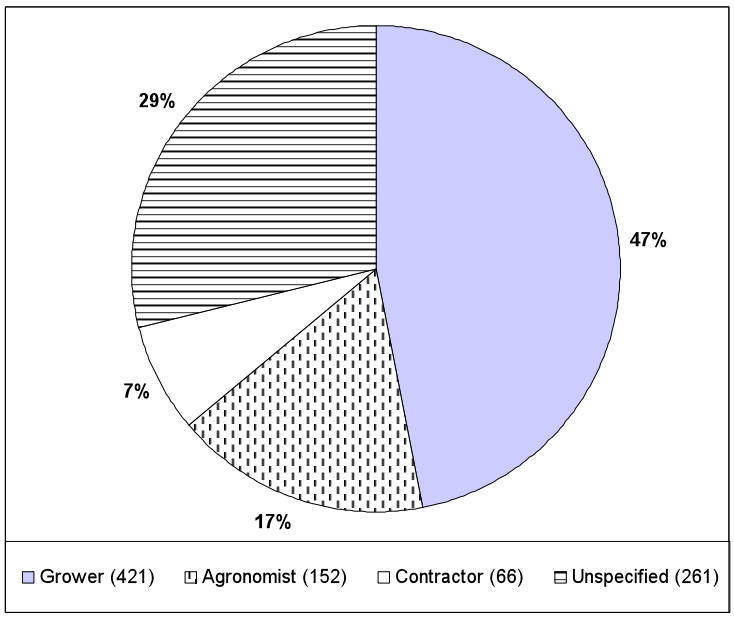

Figure 1: Percentage of surveyed canola industry groups (2009–2012)

Note: Numbers of individuals are shown in brackets.

Telephone survey

The first question aimed to determine what practices and skills people used in their crop assessments to determine an optimal windrowing time.

Q. What do you do when inspecting a crop to determine the optimum time to windrow? How do you assess the crop? What parts of the plant do you examine? What are you looking for?

Answers elicited a range of approaches in the indicators used to trigger closer examination of the crop. These included various 'rules of thumb' based on calendar days relative to sowing dates, different stages of flowering and 'Melbourne Cup Day', and generalised changes in overall crop and pod colour.

Crop inspection

Most frequent were comments mentioning generally random selection of individual plants from representative areas across a crop area. Several comments emphasised the importance of regular inspections every few days to gauge the rate of seed colour change.

Crop canopy colour change

Overall crop colour changes were frequently mentioned as the prompt to examine seeds within pods. There was mention of specific individual varieties whose overall changes in canopy colour were indicative of the level of seed colour change, however there were some contradictions regarding which varieties were deemed to be reliable indicators. Comments from other respondents claimed the same variety to be "misleading" or "unreliable", with seeds still green within pods that had changed colour.

Sections of the crop canopy

Close crop inspection revealed a diversity of practices. For some there was a narrow focus as to the position within the plant, pods and seeds were inspected, checking seeds within pods located on the main stem, the "middle of the main stem" and the "top". For others it was more generalised, "look at the whole plant", "top to bottom". A small number were not really sure or specific – "somewhere in the canopy".

Levels of seed colour change

The level of seed colour change deemed to be optimal to commence windrowing varied between 10 and 100%. Of the 140 telephone surveys, only 11 respondents nominated the industry guideline of 40–60% seed colour change. Thirty-nine respondents did not nominate any specific level of colour change.

Seed colour change

The term 'colour change' was interpreted differently by individuals, some strongly adamant as to what constituted 'colour change', others more casual. For example, seed may have to show "discolouration", "just a speck of colour", "any colour", "beyond the green", "bronze", "caramel", "brown smudge", "light brown", "brown", "black" and "jet black", Some specified it had to be black, others "not black!" or "not necessarily black". The firmness of the seed when rolled between their fingers was referred to by 15% of respondents, "not mush" and "as long as green seeds are firm."

A question was asked to reflect the general attitude towards the importance of windrowing timing on crop profitability.

Q. How would you rate the importance of windrowing timing on overall crop profitability? (high / medium / low)

Table 1: Attitudes of industry groups to windrowing effects on crop profitability

	Percentage (%) of respondents			
Rating	Agronomist	Grower	Contractor	Overall
High	72	70	80	72
Medium	20	23	15	21
Low	8	7	5	7

Combined surveys

The results from this point forward encompass the combined responses of both the telephone survey (NSW only) and surveys conducted at field days, updates and meetings in NSW, Victoria and South Australia in between 2009 and 2011. These represent the responses from 900 industry participants.

Several questions were aimed at gaining an insight into people's level of knowledge and understanding of crop growth and development and general plant physiology. At the same time, answers reveal the perceived magnitude and therefore potential losses and gains to be made with varying windrowing time outside from the optimum.

Q. Respondents were asked to specify what the oil and yield would be if windrowing occurred 3-4 and 7-10 days earlier than the designated optimum day and 3-4 and 7-10 days later. It was reinforced to respondents that it was assumed that there were no adverse factors impacting on the crop such as wind and shattering.

***Optimum timing of windrowing – effects on oil and yield* – The scenario was described where a crop was growing with no limiting factors (including moisture, temperature, nutrition, disease and weeds) and given optimum timing on a nominated day, oil levels were 42% and yield was 2.5 t/ha.**

Optimum level of seed colour change

The industry guideline to determine timing of windrowing is described as follows:

- Assess pods collected from the main stem.
- 40–60% of seeds have changed colour from green to red, brown or black.
- Seeds in the pods at the top of the main stem may be green but are firm when rolled between the thumb and forefinger.

Table 2 shows the comparative frequency of the different industry groups that specifically mentioned 40–60% seed colour change as the optimum stage to windrow canola. A total of 50 people out of 900 surveyed nominated 40–60%.

Table 2: Comparison of industry groups specifically nominating 40–60% seed colour change

	Frequency				
	Agronomist	Grower	Contractor	Unspecified	Overall total
40–60% seed colour change	23	22	4	1	50

Table 3: Frequency of answers nominating level of seed colour change for optimum windrowing time

	Frequency				
	Agronomist	Grower	Contractor	Unspecified	Overall total
No mention of specific colour change target/range	22	52	5	113	192
Seed colour change:					
< 40%	20	57	14	15	106
40 – 60%	114	267	41	35	457
> 60%	42	138	19	28	227

Note: Many answers include ranges that fell into more than one category. For example someone who nominated 30–50% would be included in both categories < 40% and 40–60% seed colour change; or an answer of 30–70% would be included in all three categories.

Analysis revealed no significant difference between the industry groups (growers – agronomists – contractors), that specified seed colour change in any of the < 40%, 40–60% or the >60% categories (Table 3).

When considering differences between industry groups, approaching significance was a higher proportion of **contractors** giving a **minimum colour change less than 40%;** i.e. where contractors nominated a range, the lower end of the range was below 40% seed colour change.

Similarly, analysis showed a higher proportion of **growers** giving a **minimum colour change greater than 60%**, indicating a greater proportion of growers believed optimum windrowing time is when more than 60% of seed has changed colour.

Timing impact on oil content and yield

Table 4 and Table 5 show the overall expectations of oil and yield if the crop was windrowed 3–4 days either side of optimum and 7–10 days either side of optimum by all industry groups combined.

Table 4: Summary of expected changes in OIL from 42% with timing of windrowing

Timing	*Percentage (%) of respondents*			
	7–10 days early	3–4 days early	3–4 days late	7–10 days late
Decrease	87	78	19	27
No change	3	12	37	22
Increase	1	2	36	43
No answer	9	8	8	8
Median (oil %) Range (oil %)	38 10 – 61	40 10 – 57	42 10 – 75	42 5 – 80
	x^2 = 5.5151, p = 0.2254	x^2 = 3.2711, p = 0.5272	x^2 = 0.875, p = 0.922	x^2 = 4.9088, p = 0.3108

Windrowing early was generally believed to result in an oil penalty, however 12% of respondents believed timing just 3–4 days early would not affect final oil levels. The effects of later windrowing on oil however were more diverse with distinctly opposing views. A delay of 3–4 days later was expected to decrease oil content by 19% of respondents, whereas 36% anticipated further oil increases. No change in oil was expected by 37% of respondents, with 8% not giving a view at all.

This variation of viewpoints was the main trigger for this survey and its associated research work.

Table 5: Summary of expected changes in YIELD from 2.5 t/ha with timing of windrowing

Timing	*Percentage (%) of respondents*			
	7–10 days early	3–4 days early	3–4 days late	7–10 days late
Decrease	80	60	25	44
No change	7	28	44	23
Increase	4	3	22	25
No answer	9	9	9	8
Median (yield t/ha) Range (yield t/ha)	2.2 1.0 – 3.1	2.4 1.5 – 3.0	2.5 1.8 – 3.0	2.5 1.0 – 3.5
	x^2 = 6.5345 p = 0.1494	x^2 = 8.6348, p=0.06747	x^2 = 8.4748, p=0.07296	x^2 = 8.9189, p=0.06047

The impact of windrow timing on final crop yield (in the absence of shattering) revealed a diverse range of views. Timing 7–10 days early was considered to have no impact on final yield by 7% of respondents. The majority (80%) expected some yield loss, as much as 1.5 t/ha loss i.e. a 1.0 t/ha yield. Four percent of respondents anticipated an increase in yield by as much as 0.6 t/ha.

Timing windrowing 3–4 days early was viewed by 60% to reduce yield by as much as 1.0 t/ha, in contrast to 28% who considered yield to be unaffected, i.e. 2.5 t/ha.

The perceived yield impacts of delayed windrowing were mixed. For example, if windrowing took place 3–4 days later, 44% believed there would be no change from 2.5 t/ha, 22% predicted further yield increases of up to an additional 0.5 t/ha, and 25% believed there would a loss in yield by as much as 0.7 t/ha.

Windrowing delays of 7–10 days revealed 44% of respondents expected yield losses by as much as 1.5 t/ha.

Differences in expectations between industry groups

The survey included analysis of the understanding of different groups in industry, contractors, growers and agronomists. There was no significant difference between industry groups in their understanding of windrow timing on crop yield or oil content. For details of the findings, refer to Appendix (page 13).

Industry experience

There has been a three-fold increase in the Australian canola crop area over the last decade, increasingly viewed as an important and profitable crop phase in crop production systems across a wide range of growing environments. At the same time, the increasing complexity of agricultural technology has resulted in the increased use of the professional services of agronomists and consultants (hereafter referred to as agronomists) to advise on crop management.

Table illustrates the diverse level of experience amongst particular industry groups, with 39% of those surveyed having 5 years or less experience. It reflects the rapid expansion of the national canola crop in recent years.

Table 6: Canola industry groups and years of experience

Canola experience (years)	*Percentage (%) of respondents*				
	Agronomist	Grower	Contractor	Unspecified	Overall
1 – 5	35	42	30	49	39
6 – 10	23	19	20	27	22
11 – 20	26	30	36	16	27
21 – 30	12	6	11	7	9
31+	4	3	3	1	3

Data analysis revealed a large proportion of industry participants were working in their initial year with canola (Figure 2). Of the 142 respondents who stated it was their first year of working with canola, 71 (or 50%) were growers. This is perhaps a little misleading as 27% of respondents who marked down their experience as 1 year only, did not nominate their role. This survey was largely carried out at various events where most of the audience was made up of growers, hence it is reasonable to assume that this proportion is in reality greater than 50%.

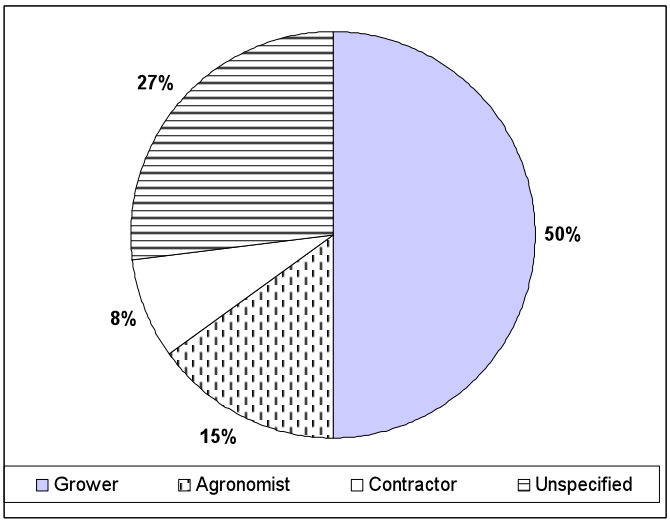

Figure 2: Percentage of industry groups with one year of canola experience

Correlations with years of experience in the canola industry were also examined; there was no significant difference in responses to **oil content** related to optimal windrowing time. Figure 3 illustrates the mix of responses, all demonstrating large variations in answers to identical questions.

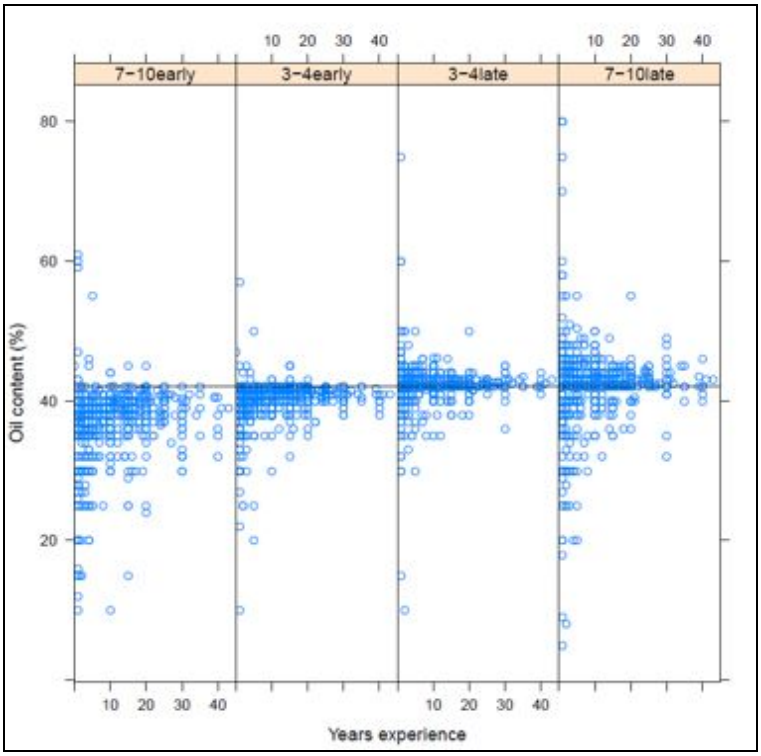

Figure 3: Level of experience and expected OIL content with different windrow timing

Similarly, examining correlations with years of experience revealed no significant difference in responses to grain **yield** related to optimal windrowing time. There was a trend that the expectation of an increase in yield with late windrowing decreases with years of experience (Figure 4). A period of 3–4 days either side of the optimum would be typical in many crops with variations in crop maturity. Perceptions of how these different crop maturities affect yield ranged between losses as high as 1.0 t/ha to gains of an additional 0.5 t/ha.

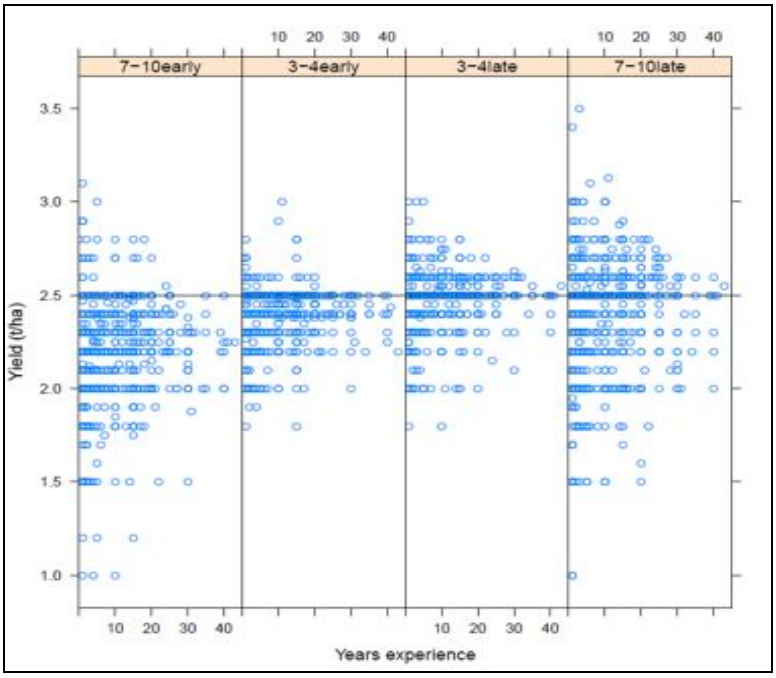

Figure 4: Level of experience and expected YIELD with different windrow timing

Other survey revelations

Industry 'wisdom'

An almost universal comment that arises when the topic of windrowing canola is discussed includes references to rules of thumb, generally accepted guidelines and often repeated motherhood statements. Constant repetition of a statement does not make it a fact.

Whilst it is understood that in any crop situation there are always many variables to consider, "Canola is a different beast in the way it matures every year", there was widespread recognition that different messages and interpretations were common. Frequently during conversation, many respondents said they didn't really know, a lot of the "pub talk" often didn't match their expectations and it raised more questions.

There are high levels of frustration with the mixed messages and the logistical realities. These were reflected in many comments, including – "compromise between textbook and practicalities", "We got a problem here, everyone goes agronomic style!", "Some do some really crazy timing", "We just do what the southerners tell us to do!" "All the psychology of it, that's the problem", timing of windrowing is normally "when the contractor gets there." At the same time it is often noted that there are large variations or very different versions and contradictions with many – "half a dozen opinions in every district".

This has created a lot of confusion, with less experienced growers and agronomists who are seeking information, discovering many viewpoints – "we made a lot of phone calls last year and no one really knew, a lot of different answers", and contractors encountering a wide range of opinions and beliefs.

Widespread beliefs

Cutting height and seed 'fill'. Crop cutting height for some growers and contractors was a very deliberate decision, and at times topical.

Most canola crops are cut at between 30 and 40 cm from ground level, however there were preferences to cut as low as 10 cm, whilst others preferred 60–65 cm. Reasons given for definite cutting height included improving the stability of the windrow through holding the crop in the first fork in the stem with higher cutting height, to cutting lower to maximise the opportunity for "sap"/"nutrients"/"goodness"/"substrate" in the stem to continue to fill the seed, with the mistaken belief that additional oil and yield would be gained with longer stems.

What is colour change?

There were many and varied comments describing 'colour change'. For many it was almost a casual reference as something often repeated. When asked to be more specific in their answer, it quickly became apparent there was considerable diversity in what represented 'colour change'. Responses included some very firm convictions regarding how a seed looked when it could be safely windrowed without oil or yield penalty.

During discussions, many referred to 'pod colour change', but when questioned further said it was a slip of the tongue and that they meant to say seed colour change. This confusion was referred to several times, particularly by some of the more inexperienced growers and agronomists.

Future directions

This report identifies large knowledge gaps in the canola industry. The most frequently mentioned areas of additional information that were sought included:

- improved understanding of how the timing of windrowing effects oil content and yield;
- the truth and accuracy surrounding some of the common motherhood statements and practices
- information to assess the timing of windrowing effects on the value of additional oil vs value of shattering losses including margins of error;
- comparing direct heading vs windrowing;
- varietal differences in pod shattering and changes in pod colour; and
- independent scientific assessment of commercial products to reduce shattering.

Overall, there is a strong push to refine current production practices, to understand the reasons behind variable crop performance. This requires understanding the physiology of the crop during late reproductive development including seed maturation and oil and yield accumulation. Attitudes to canola are reflected in comments like "There's a fair bit of black magic in growing canola", "It's a voodoo crop" and "It's the biggest mystery crop out there."

With strong industry focus on the economic management and outcomes of canola production, confidence in industry recommendations and guidelines would improve through better understanding of crop physiology. Canola crop income is based on oil content as well as yield so improved knowledge of the processes occurring within the seed is crucial. This information would allow better understanding and greater confidence by all collaborators of the impact of decisions, particularly economic consequences.

References

- Anonymous, 2008. Monitoring, evaluation, reporting and improvement (MERI) Clear Horizon – DPI NSW
- Hertel K 2009. Canola windrowing paddock survey report (unpublished)
- Hertel, K. 2010. Windrowing canola – impact on harvest losses and quality. Dubbo Grains Research Update, GRDC, 24 February 2010. pp.113–120
- Hertel KA 2011 "Windrowing canola – Current industry practices and perceptions" *in Proceedings – Australian Research Assembly on Brassicas*, Wagga Wagga, 15–17 August 2011. pp 172–176

More information

Kathi Hertel, M. 0427 104 344 E. kathi.hertel@dpi.nsw.gov.au

Acknowledgments

This work was jointly funded by NSW DPI and the GRDC funded Better Break Crops Project (PAL 00017). Thank you to all survey participants for your time, knowledge, suggestions and enthusiasm. Thank you to Neil Coombes NSW DPI for statistical analysis.

APPENDIX

Differences in expectations between industry groups

Tables 7–10 reveal the differences in crop performance expectations to windrowing timing between the various industry groups.

Timing effects on oil content

Table 7: Expected changes in OIL compared to optimum windrowing timing: 7–10 days earlier than optimum

	Percentage (%) of each industry group			
	Agronomist	**Grower**	**Contractor**	**Unspecified**
Decrease	95	89	86	66
No change	2	3	8	1
Increase	2	1	0	2
No answer	1	7	6	31
	$x^2 = 5.5151$, $p = 0.2254$			

There was no significant difference between the industry groups for the expected change in oil content if a crop was windrowed 7–10 days early. In all groups, the majority predicted lower oil content.

Table 8: Expected changes in OIL compared to optimum windrowing timing: 3–4 days earlier than optimum

	Percentage (%) of each industry group			
	Agronomist	**Grower**	**Contractor**	**Unspecified**
Decrease	85	82	77	57
No change	13	11	15	10
Increase	1	2	5	1
No answer	1	5	3	32
	$x^2 = 3.2711$, $p = 0.5272$			

There was no significant difference between the industry groups for the expected change in oil content if a crop was windrowed 3–4 days early. In all groups, the majority predicted lower oil content. Notable is the relatively consistent proportion within each group who believed that a few days early would have no impact on final oil levels.

Table 9: Expected changes in OIL compared to optimum windrowing timing: 3–4 days later than optimum

	Percentage (%) of each industry group			
	Agronomist	**Grower**	**Contractor**	**Unspecified**
Decrease	28	19	15	17
No change	63	37	39	30
Increase	2	39	41	21
No answer	7	5	5	32
	$x^2 = 0.875$, $p = 0.922$			

There was no consistent view of the impacts on oil of delayed windrowing by just 3–4 days by any one group. All groups revealed opinions including losses of oil, increases in oil and no change in oil.

Table 10: Expected changes in OIL compared to optimum windrowing timing: 7–10 days later than optimum

	Percentage (%) of each industry group			
	Agronomist	Grower	Contractor	Unspecified
Decrease	25	28	18	25
No change	20	23	23	17
Increase	53	44	55	26
No answer	2	5	4	32
	$x^2 = 4.9088$, $p = 0.3108$			

Table 10 reveals diversity of views regarding the impact on oil of windrowing 7–10 days late. Generally, approximately one-quarter of each group believed there would be either a loss in oil or no change at all, with around half expecting further oil increases. There was no significant difference between the groups.

Timing effects on grain yield

Table 11: Expected changes in YIELD compared to optimum windrowing timing: 7–10 days earlier than optimum

	Percentage (%) of each industry group			
	Agronomist	Grower	Contractor	Unspecified
Decrease	89	83	76	60
No change	7	7	11	6
Increase	0	4	5	3
No answer	4	6	8	31
	$x^2 = 6.5345$, $p = 0.1494$			

The majority of respondents believed there would be yield penalties if a crop was windrowed 7–10 days before the optimum. There was no significant difference between the groups.

Table 12: Expected changes in YIELD compared to optimum windrowing timing: 3–4 days earlier than optimum

	Percentage (%) of each industry group			
	Agronomist	Grower	Contractor	Unspecified
Decrease	70	63	50	44
No change	26	28	39	21
Increase	1	4	5	3
No answer	3	5	6	32
	$x^2 = 8.6348$, $p=0.06747$			

While the main view was there would be some yield loss if a crop was windrowed 3–4 days earlier than the optimum, the expectation of no change in yield increased in all groups.

Table 13: Expected changes in YIELD compared to optimum windrowing timing: 3–4 days later than optimum

	Percentage (%) of each industry group			
	Agronomist	**Grower**	**Contractor**	**Unspecified**
Decrease	18	27	18	8
No change	52	44	55	36
Increase	28	23	18	15
No answer	2	6	9	41
	$x^2 = 8.4748$, p=0.07296			

Overall views regarding the impact on yield of windrowing 3–4 days late become much more diverse. Generally, between one-fifth and one-quarter of each group believed there would be either a loss in yield or an increase in yield, with around half expecting no change at all. There was no significant difference between the groups.

Table 14: Expected changes in YIELD compared to optimum windrowing timing: 7–10 days later than optimum

	Percentage (%) of each industry group			
	Agronomist	**Grower**	**Contractor**	**Unspecified**
Decrease	36	46	33	41
No change	25	22	30	16
Increase	36	27	27	11
No answer	3	5	10	32
	$x^2 = 8.9189$, p=0.06047			

The yield impacts of longer delays to windrowing; (7–10 days) were generally viewed more evenly across losses, gains and no change in all groups. For example, amongst agronomists, 36% believed there would be some decrease in yield, 36% believed there would be an increase in yield, whilst 25% believed there would be no change at all. Contractors were similarly split, while almost half of growers believed there would be a yield loss, even in the absence of any shattering.

There was no significant difference between industry groups in their understanding of windrow timing on crop yield.