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INCORPORATING THE WEED SCIENCE SOCIETY

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Next Meeting	**'New Year, New Updates'**
Venue	**Richardson Theatre, Roseworthy Campus**
Date	**THURSDAY 19th FEBRUARY**
Time	**7.30 pm**

********NOTE DATE CHANGED TO THURSDAY********

Speakers

Rob Wheeler – SARDI

Rob is a seasoned campaigner in the South Australian Ag sector and there is not much he doesn't know about past, current & new crop varieties. Rob will cover topics like, new cereal varieties, what you should be growing, and pull some interesting details out from that colossal database that is NVT to make this topic of great value and interest to everyone.

Peter Boutsalis: University of Adelaide & Plant Science Consulting

Peter is a Collingwood supporter, but we will not hold that against him. The credibility he loses for supporting Collingwood, he more than makes up for with his extensive experience working on herbicide resistance. Peter will cover the topic of Glyphosate resistance, something that has become quite common at a paddock level in recent years. Peter will discuss its prevalence, how it works and what can we do to manage this serious problem.

Harvest weed seed control – Narrow windrow burning

Sam Kleemann[1], Sarah Noack[2], Gurjeet Gill[1] & Chris Preston[1]
School of Agriculture, Food & Wine, The University of Adelaide[1]
Hart Field Day Group[2]

Key Findings

- Narrow windrow burning canola can be an effective tactic against ryegrass provided weed seeds can be captured and concentrated at swathing & harvest
- Of the ryegrass seed captured between 93-99% was controlled by burning narrow windrow canola

Why do the trial?

Weed seed kill levels of 99% for both annual ryegrass and wild radish have been recorded from the narrow windrow burning of wheat, canola, and lupin chaff and straw residues (Walsh and Newman 2007). The simplicity and low cost of this narrow-windrow system has resulted in its adoption by an estimated 70% of crop producers in the major grain production state of Western Australia. In South Australia the adoption of this practise is not as high as there have been a limited number of trials able to show the reduction in weed seed number.

How was it done?

Three growers in the Mid-North who were planning to narrow windrow burning canola provided paddock for this study. Prior to narrow windrows being burnt in early 2014 an assessment of canola stubble/cutting height (cm) and biomass (t/ha) in the narrow windrow were assessed. A 5 m section of chaff was removed in five rows to represent a non-burnt area.

After the narrow windrows were burnt, 10 soil samples (7 cm diameter core x depth 10 cm) were taken from five replicates per paddock in the following three locations:

1) Burnt section of windrow
2) Sample within 3 m on the non-burnt section
3) Inter-row

These 10 soil samples were combined to make one bulk sample per treatment. The soil samples were then transferred to shallow trays and germinating ryegrass assessed at regular intervals. Census of ryegrass was ceased when no new seedlings emerged over a 3-week period. Ryegrass seed number was determined from the total number of ryegrass seedlings to germinate, and the total area sampled (i.e. core area (πr^2) × number of cores sampled (n=10)) and converted to a unit area (i.e. seeds/m^2).

Table 1. Cutting height and stubble biomass of canola from 3 field sites across Mid-North of SA.

Site	Stubble/cutting height (cm)	Stubble biomass (t/ha)
1	42.8	2.8
2	31.6	2.4
3	34.0	2.6

Results and discussion

Effectiveness of narrow windrow burning of canola is governed by the amount of weed seed captured and accumulated in the windrow by the swathing and harvest operation. Whilst ryegrass shows less of a tendency to shed seed relative to other grasses (i.e. wild oats, brome grass), it can be prone to lodging reducing the amount of seed collected. Furthermore, there has been some suggestion that ryegrass is more prone to lodging in canola than other crops because of a reduction in stem strength resulting from increased crop shading.

The effectiveness of seed capture and accumulation under narrow windrows was apparent at 2 of the 3 study sites, where up to 13-fold more ryegrass seed was found in the narrow windrow in comparison to the adjacent swath area (Table 2). The exception was site 1, where seed accumulation was only 2-fold higher in the narrow windrow. At this site the cutting height of canola was 10 cm higher (42.8 cm) than at sites 2 (31.6 cm) and 3 (34 cm), and much of the ryegrass had lodged according to the grower. This would have reduced the effectiveness of both the swathing and harvest operations to capture and concentrate seeds in the windrow. To improve seed capture some consideration must therefore be given to both the growth habit of ryegrass and subsequent swathing height.

Often cutting height of canola varies with the height and biomass of the crop at maturity and subsequently the cultivar grown. Not surprisingly hybrid-cultivars, which have tendency to grow taller, are usually swathed higher than their shorter TT-relatives. Consequently ryegrass is less likely to be captured under taller hybrids than TT-cultivars unless swathing height is adjusted accordingly.

Table 2. Effect of swathing and harvest on ryegrass (seeds m^{-2}) accumulation in narrow windrows at 3 field sites across the Mid-North of SA. Values in parenthesis represent SE (±) around the mean of five replicates.

Site	Narrow windrow	*Between windrow	Increase in ryegrass seed accumulation in narrow windrows
	ryegrass seed (no./m^2)		
1	8210 (1357)	3829 (820)	2.14-fold
2	8563 (789)	644 (231)	13.3-fold
3	10600 (979)	805 (271)	13.2-fold

*Between windrow represents swath area outside of narrow windrow.

When canola and ryegrass were concentrated in narrow windrows, soil surface temperatures during burning were hot enough and their duration sufficient to kill >93% of ryegrass seed (Table 3). At site 3, the control was as high as 99%, with less than 52 viable seeds remaining in the burnt versus a possible 10600 seeds/m^2 in the unburnt windrow, respectively.

Pervious research from WA (Walsh & Newman 2007) showed that given sufficient canola residue had been concentrated burn temperatures exceeding 600°C were possible and well in excess of the 400°C required for at least 10 seconds to guarantee the death of ryegrass seeds. Their research concluded that higher biomass levels in narrow windrows increased mortality of ryegrass by increasing both burning temperatures and duration of these higher temperatures. They also found that wind speeds (higher better than low) were important by maintaining more consistent burning temperatures, improving the ability of the windrow to burn to the soil surface.

There are, however, some noteworthy disadvantages to burning narrow windrows which include summer rain reducing burning temperatures, associated unburnt residue heaps and trash flow issues at sowing, risk of burning entire field leading to increased erosion (less of problem with narrow than conventional windrows), redistribution of nutrients such as potassium in windrow area, and loss of important nutrients such as nitrogen and sulphur lost in smoke.

Table 3. Ryegrass (seeds m^{-2}) following burning of canola stubble concentrated into narrow windrows at 3 field sites across the Mid-North of SA. Values in parenthesis represent SE (±) around the mean of five replicates. Two-tailed *t*-tests were performed to compare between burnt and unburnt windrow treatments.

Site	Windrow treatment: Burnt	Windrow treatment: Unburnt	Ryegrass control	*P-value* Burnt Vs. unburnt
	ryegrass seed (no./m^2)		(%)	
1	540 (236)	8210 (1357)	93	***
2	88 (18)	8563 (789)	99	***
3	52 (15)	10600 (979)	99	***

*** $P < 0.001$.

Summary / implications

Narrow windrow burning canola appears to be an effective tactic for late seed set control of ryegrass provided weed seeds can be captured and concentrated into narrow windrow at swathing and harvest. To improve seed capture some consideration must be given to both the growth habit of ryegrass (lodged vs. erect) and subsequent swathing height (i.e. lodged ryegrass will require lower swathing height). Although not covered in this study, timing of swathing will also influence seed capture with earlier timing improving likelihood of capture as less ryegrass will have shed seed.

In canola, concentration of stubble residues into a narrow windrow using a simple chute mounted to the rear of the harvester is critical to obtain the fuel loads to achieve a longer, more reliable burn to the soil surface. A minimum of 400°C is required for at least 10 seconds to kill ryegrass seed (Walsh & Newman 2007); canola in narrow windrows can produce temperatures in excess of 600°C.

Our study showed that of the ryegrass seed captured, between 93 and 99% was controlled following burning of canola stubble concentrated into narrow windrows. This provides growers an excellent opportunity for late seed set control, particularly in situations where grass selective herbicides (i.e. Select®) have failed due to resistance and sizeable seedbank replenishment would undoubtedly cause production problems in the next crops of the rotation.

Acknowledgements

The financial assistance of GRDC is gratefully acknowledged. We also wish to thank Malinee Thongmee (UA) for providing technical assistance.

References

Walsh, M. and Newman, P. (2007) Burning narrow windrows for weed seed destruction. Field Crop Research 104, 24-30.

Managing sowing date and variety selection to minimise risk and maximise yield

Andrew Egarr, James Edwards, Dan Vater and Haydn Kuchel
Australian Grain Technologies (AGT), Roseworthy Campus

Key messages

- Estoc yields best when sown early.
- Axe yields best when sown later.
- Mace yields best when sown mid-May but tends to out-yield most other varieties at all sowing times.
- In regions where frost risk is much lower than heat risk, Axe types may be the better option for all but the earliest sowing times. This strategy may also be an advantage in a terminal drought.

The maturity types of wheat can be roughly allocated into one of three groups. The first group are photoperiod sensitive varieties (e.g. Yitpi) which require day length to be greater than 10 hours before flowering will occur. This photoperiod requirement can be satisfied by the longer days in autumn and therefore, sowing photoperiod sensitive varieties before April may result in early flowering (mid-winter). The second group are vernalisation responsive (e.g. Wyalkatchem). These varieties require minimum temperatures below 10^{0}C (optimum 6^{0}C) over periods ranging from 2-8 weeks for the plants to move from vegetative phase to reproductive phase, depending on variety. The final group display minimal or no sensitivity to both photoperiod and vernalisation (e.g. Axe). These varieties mature predominantly in response to temperature. Although each variety can be classified into these types, once the photoperiod and vernalisation requirements have been satisfied there is still variation in maturity rate between varieties. This is described as "earliness per se" and reflects multiple factors influencing maturity progression independent of vernalisation and photoperiod sensitivity.

Table 1 shows the vernalisation, photoperiod and "earliness per se" requirements of the well known varieties Axe, Wyalkatchem and Yitpi. Alternative varieties are shown in Table 2, grouped according to their photoperiod and vernalisation requirements. However, the requirements for vernalisation or photoperiod vary between each variety within each group. For example, Yitpi and Estoc are more sensitive to photoperiod than Gladius, and therefore flower later than Gladius, while Bolac combines vernalisation and photoperiod sensitivity and therefore flowers later than both Mace and Yitpi. Strategic use of these different maturity types can extend the sowing period while minimising the risk of grain yield loss due to frost and heat events. In this report we have featured Mace and Estoc as higher yielding replacements for Wyalkatchem and Yitpi, respectively.

Table 1: Thermal time (cumulative daily temperature) required for vernalisation, photoperiod response and earliness per se in Axe, Wyalkatchem and Yitpi. Adapted from Brougham, 2006.

Variety	Vernalisation (^{0}C)	Photoperiod (^{0}C)	Earliness per se (^{0}C)
Axe	0	525	910
Wyalkatchem	221	840	924
Yitpi	0	1974	1176

Table 2: Common wheat varieties grouped by their maturity type.

Minimal photoperiod and vernalisation sensitivity	Vernalisation sensitive		Photoperiod sensitive	
Axe	Bolac	Moderate	Correll	Moderate
Bonnie Rock	Cobra	Moderate	Estoc	Strong
Corack	Elmore CL Plus	Moderate	Frame	Strong
Emu Rock	Gregory	Moderate	Gladius	Moderate
Scout	Janz	Moderate	Grenade CL Plus	Moderate
Spitfire	Mace	Moderate	Justica CL Plus	Moderate
Wallup	Naparoo	Strong	Trojan	Moderate
Westonia	Shield	Moderate	Yitpi	Strong
	Wedgetail	Strong		
	Wyalkatchem	Moderate		

How was it done?

AGT conducts 'time of sowing' trials to characterise new varieties with regard to maturity type, and to evaluate grain yield response of new and existing varieties to different sowing times. These trials provide information on how different varieties develop and progress through their life cycle, how this influences grain yield and ultimately allows us to characterise their frost and heat risk profiles.

Trials are sown at 2 -3 week intervals, starting when the season permits. In 2014, sowing dates were 24 April, 8 May, 22 May and 12 June. All plots are regularly monitored and growth stages (GS31, GS55 and GS90) are recorded.

What happened?

Variety response to temperature and day length

The thermal time (cumulative daily temperature) from sowing to the end of grain fill is longest in Wedgetail and shortest in Axe with Estoc mid-way (Figure 1). This is principally because Estoc requires long days to initiate flowering and Wedgetail has a strong requirement for vernalisation whereas Axe matures independently of day length and vernalisation. Therefore, we observe that the development of Axe is closely linked to daily temperatures, and when sown early with warm autumn temperatures, Axe has rapid early growth, quickly reaching the reproductive growth stages, increasing likely exposure to the critical frost risk period (Figure 2). Another consequence of this rapid growth is less tillering and biomass development. In contrast, Mace, Estoc and Wedgetail spend a larger proportion of the total growth period in the vegetative growth stages. This means that they spend more time tillering and developing biomass, which increases the yield potential of the plant. In addition to this, Mace, Estoc and Wedgetail have a faster grain filling period, spending at least 20% less time than Axe in the grain filling growth stage (Figure 1). This allows them to ripen quicker, reducing the risk of heat stress during grain filling

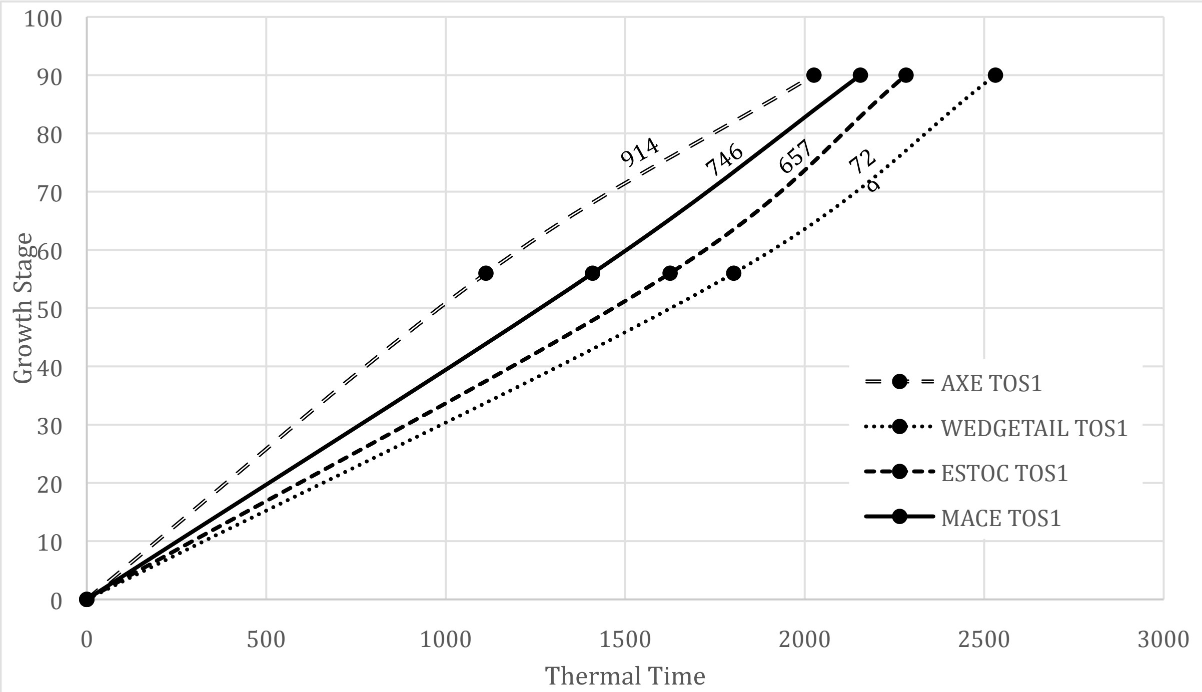


Figure 1: Thermal time (^{0}C) required to reach head emergence (GS55) and physiological maturity (GS90); Axe, Mace, Estoc and Wedgetail, first time of sowing (24 April 2014) at Roseworthy. Thermal times (^{0}C) required for each variety to complete the grain filling phase are marked.

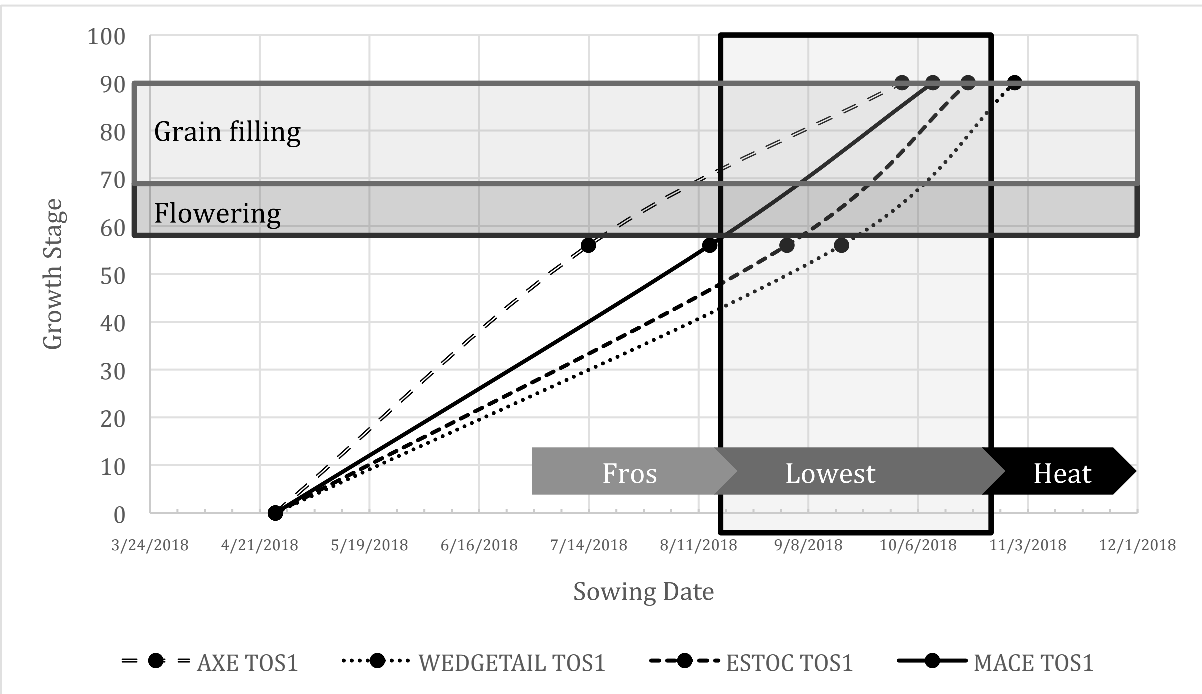
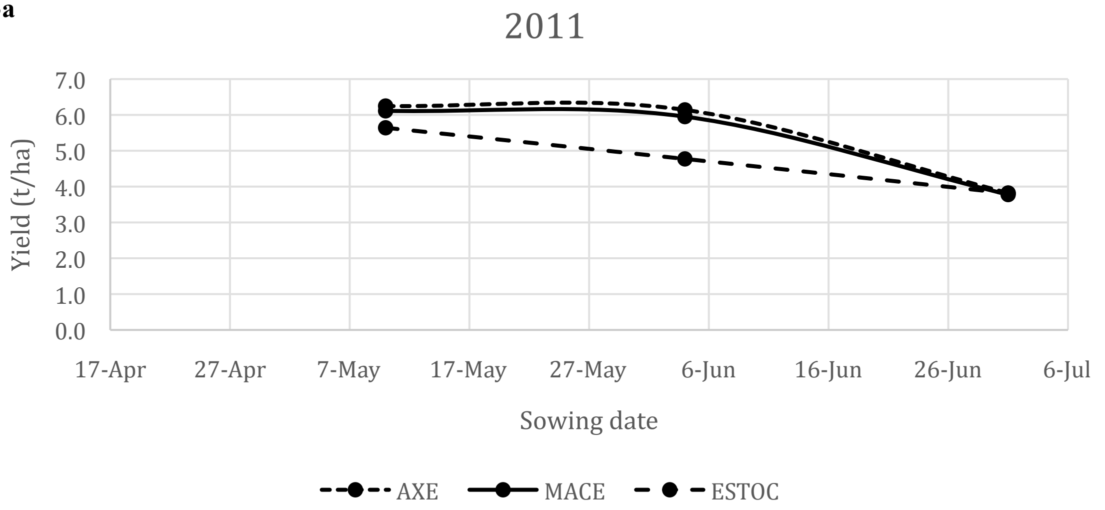


Figure 2: Differences in maturity times of Axe, Mace, Estoc and Wedgetail. Vertical rectangle represents the safe period with less than 20% chance of frost or heat stress occurring at Roseworthy (dates adapted from Zheng et al. using climatic data from 1960 - 2009). Horizontal rectangles represent flowering (GS60-69) and

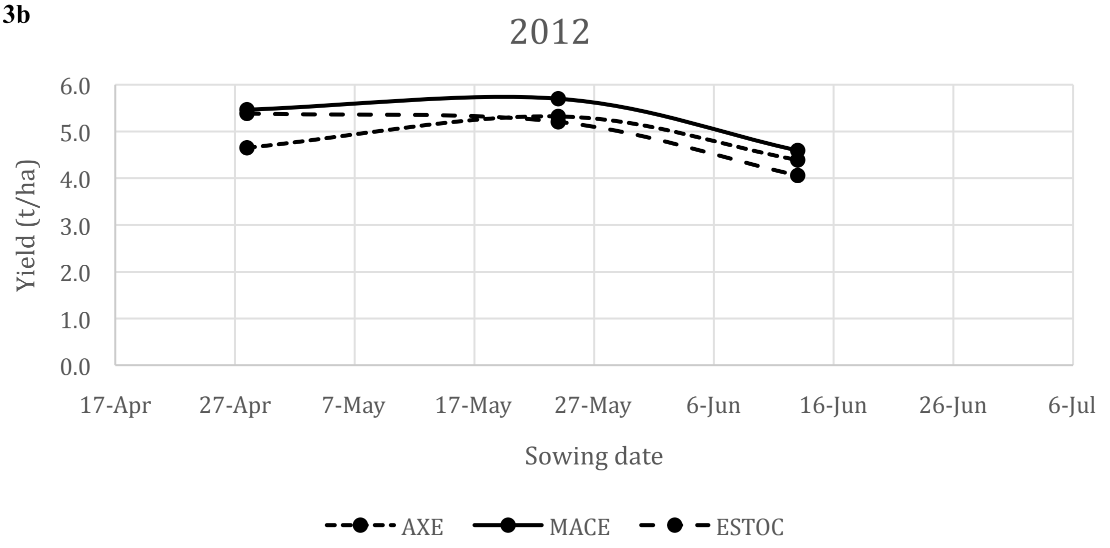
Impact of sowing date on yield

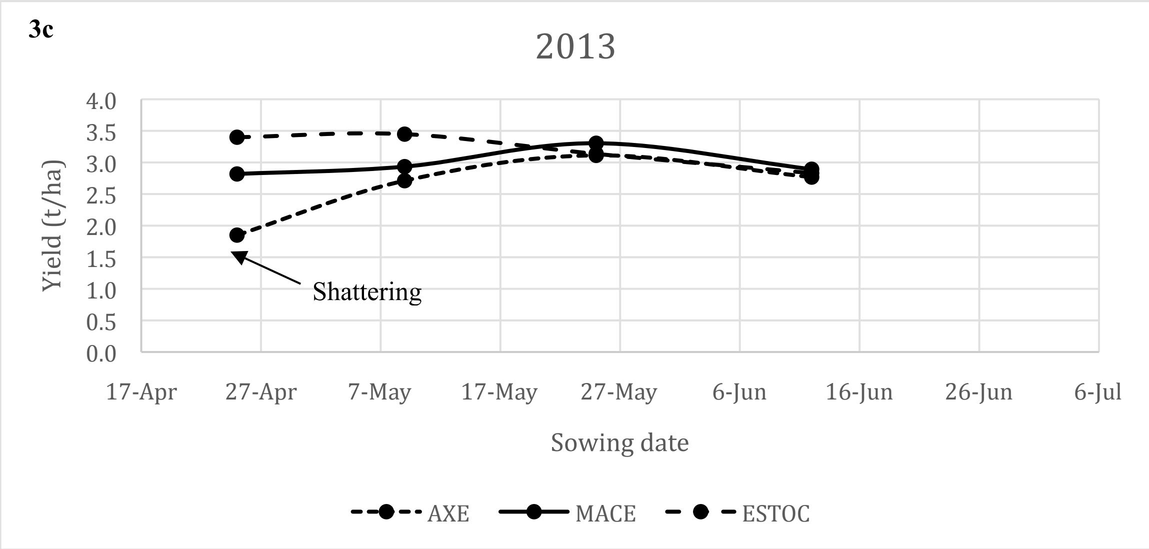
The data collected over multiple years demonstrated that the yield of each variety varied according to sowing time, with the previous four years shown in Figure 3a-3d. In general, over these trials the yield of Estoc was greatest with early sowing, reducing as sowing was delayed. The yield of Mace was relatively constant but peaked when sown in mid-May, while Axe's yield peaked at a similar point, but suffered less yield penalty when sown later. Frost in 2014 affected Mace and Axe when sown very early, exacerbating the yield penalty of sowing these varieties before their optimal sowing window (Figure 3d). A similar result was observed in 2013 when hot, strong north winds caused shattering in early sown Axe (Figure 3c).

3a



3b





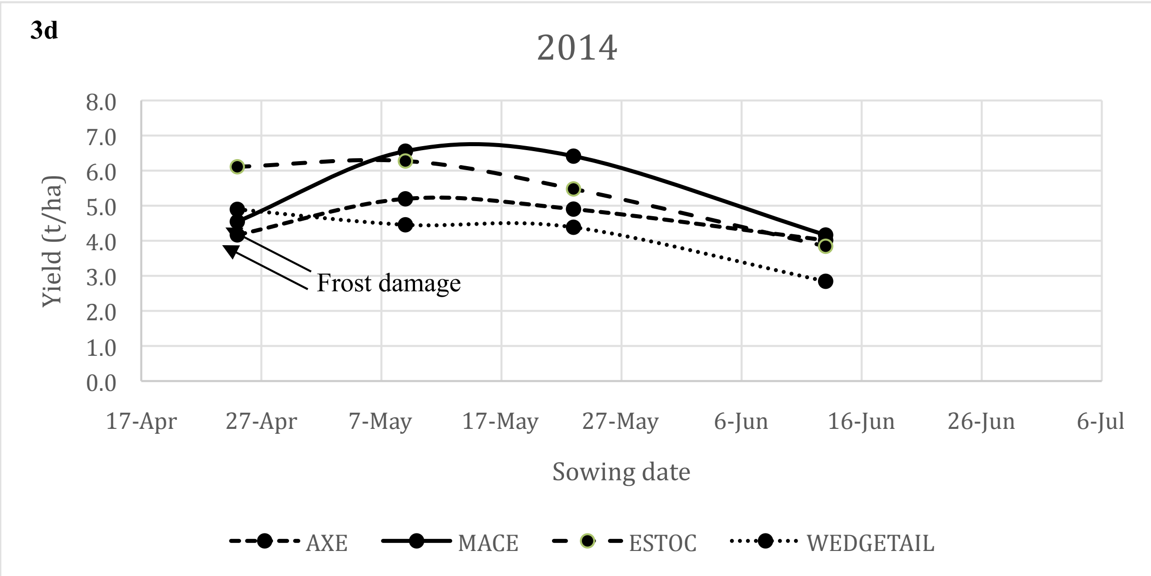


Figure 3: Grain yield results of the 2011 (3a), 2012 (3b), 2013 (3c) and 2014 (3d) Roseworthy time of sowing experiments.

What does this mean?

Selecting varieties to optimise flowering date

The length of the sowing window can be maximised by selecting a range of varieties with contrasting maturity, such as Axe, Mace and Estoc. As an example, Estoc could be used for early sowing in late April to early May, Mace for the majority of the sowing period (May) and finishing with Axe for those paddocks that might need to be sown in June. While Figure 2 shows the potential exposure to frost risk from sowing Axe or Mace in April, Figure 4 shows how a strategy of careful variety selection based on maturity type allows all paddocks sown within a 20 April to 10 June sowing window to flower and grain fill during the lowest risk period when there is a less than 20% chance of either a frost or heat stress event occurring. Currently there are no adapted varieties that can be safely sown prior to 20 April in South Australia. For example, trials at Roseworthy suggest that although the highest yield for the winter wheat Wedgetail is when it is sown in April, it is still lower than that of Estoc (Figure 3d).

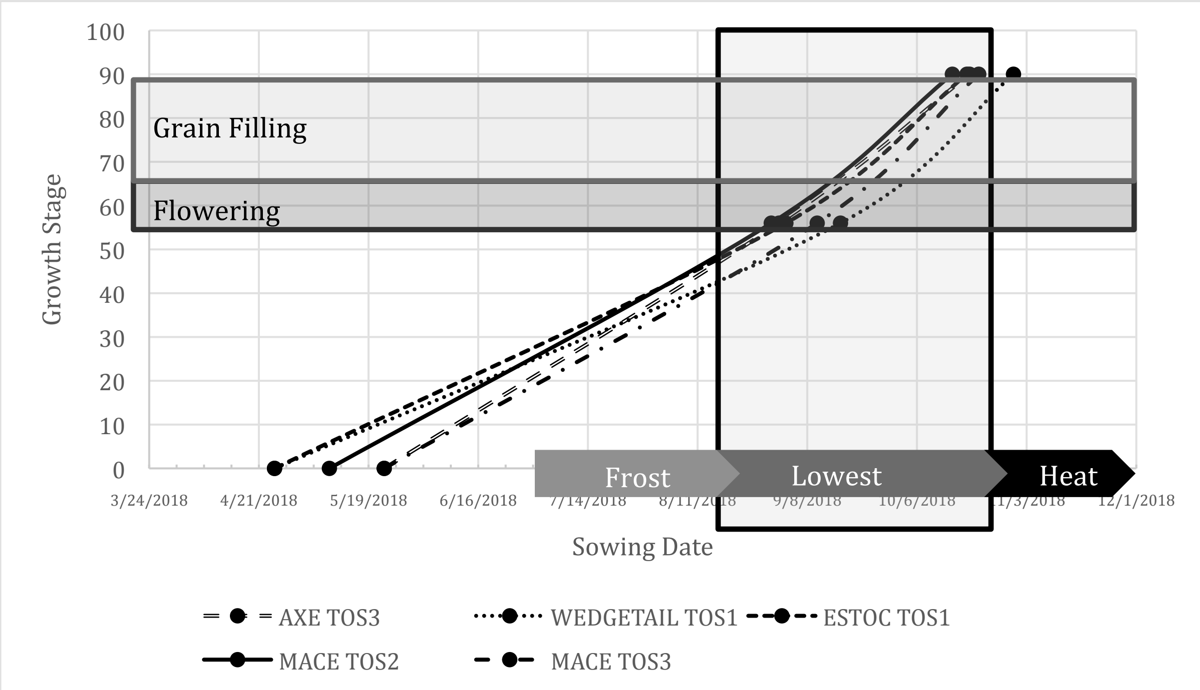


Figure 4: Managing the sowing dates of Axe, Mace, Estoc and Wedgetail to avoid major frost and heat events from 2014 time of sowing experiment at Roseworthy. GS55 and GS90 of each variety are marked. Rectangles as per Figure 2.

Selecting varieties to optimise grain yield

In order to maximise yield from whatever variety is grown, it is important to time sowing of each variety to match its yield potential. The best time to sow Estoc is late April to early May, Mace from early May to early June, and Axe from mid-May to mid-June. Although it is important to consider optimum sowing time to maximise the yield of an individual variety, the actual yield potential of each of these varieties at all sowing times should also be compared. Figures 3a-3d suggest that Mace and Estoc will yield higher than Axe at all but the latest sowing dates, in the majority of seasons. The experiments used to generate the data described in this article were grown at Roseworthy. Therefore, it is important to note that the results should be interpreted and adapted to the local environmental conditions with reference to local climatic data and grower experience.

Selecting varieties to reduce the frost and heat risks is currently the best available management practice to reduce the potentially substantial losses caused by extreme temperature events. This is achievable with the range of maturity types available in varieties that are commonly grown in southern Australia. Using Axe, Mace and Estoc as contrasting examples, this report illustrates how grain yield from each variety can be maximised while minimising the risks of yield loss due to frost and heat stress. However, using a variety with a higher inherent yield potential that may suffer some yield loss as a consequence of exposure to frost and heat events during the sensitive reproductive and grain filling growth stages may achieve higher returns than a lower yielding variety grown for its specific maturity type. For example, Mace will have a higher yield than most varieties in most environments, even when sown outside of its optimum sowing window. In this case variety selection would reflect the grower's attitude to risk and return.

Acknowledgments

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