PRE-HARVEST SPROUTING IN WHEAT AND BARLEY

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BACKGROUND

It's the last risk that growers face before reaping their rewards: rainfall at harvest! Unfavourable weather conditions during the grain filling period and throughout harvest can result in pre-harvest sprouting in cereal crops, leading to price downgrades (due to poor grain quality). When sprouting occurs in the grain, it results in an increase in alpha-amylase, an enzyme that breaks down starch. The longer the grain is subjected to unfavourable weather (multiple rainfall events and humidity), the more alpha-amylase is formed. In wheat, this can reduce flour/baking quality. In malting barley, sprouted grain can decrease its ability to germinate during the malting process, leading to undesirably high levels of beta glucan.

As germination in the grain is often not visible, the level of sprouting is measured by the 'falling numbers' test. A value of 300 seconds is the minimum standard for wheat and Malt barley.

Varieties can differ in their tolerance to pre-harvest sprouting and are influenced by factors such as the amount, timing and duration of rain events (Mares 1993), environmental conditions, architecture of the plant, such as awnless heads, head nodding angle and chaff tightness (*Young 2014*), and seed dormancy.

Seed dormancy protects the seed against germination. It develops during desiccation of the maturing grain, and then decays with time after ripeness (Mares, DJ). Many older varieties of wheat are naturally resistant to pre-harvest sprouting because they produce seeds that are strongly dormant at maturity. New varieties are often selected for other characteristics, with the result that traits maintaining seed dormancy before harvest have been lost (CSIRO).

In malting barley, seed must germinate rapidly in the malt house. Consequently, new barley varieties tend to have lower seed dormancy (and are possibly more susceptible to sprouting).

The dormancy (tolerance rating) of a variety is estimated by the germination index (GI), which is measured by collecting heads at physiological maturity and testing the speed at which an individual grain sprouts in a controlled environment (temperature, humidity, water applied).

TAKE HOME MESSAGES

1. Barley is more susceptible to sprouting than wheat, which may require more rainfall (>50mm) for sprouting to occur.

2. Protection against sprouting (seed dormancy) reduces following maturity; all varieties will become more susceptible the longer they are left standing in the paddock.

3. Grain quality diminishes with delayed harvest and multiple rainfall events.

AIM

To compare the sprouting susceptibility of new and existing wheat and barley varieties.

TRIAL DETAILS

Location:	Wemen
Soil type:	Sandy loam without sub-soil constraints
GSR:	173mm
Crop types:	Barley and wheat (refer to Table 1)
Sowing date:	12 May
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Target plant density:	130 plants/m^2
Harvest dates:	7 November (0mm treatment) 14 November (20mm treatment) 5 December (48mm treatment)

Weeds, pests and diseases were controlled to best management practice.

METHOD

Two replicated field trials were sown using a complete randomised block design. The trial was sown under irrigation (overhead sprinklers), and included three different water treatments: a control (0mm water), 20mm (one application by irrigation) and 48mm treatment. The 48mm treatment was applied in a split application (20mm at two timings) and received an extra 8mm in actual rainfall before harvest. Applying 20mm through irrigation took approximately six hours and the timing was targeted in the morning when temperatures were lower.

Varieties were chosen for their plant 'architecture' (awned vs awnless), maturity or sprouting tolerance rating. Falling numbers were tested for each treatment using a Perten Falling Number 1500 machine to determine the activity of enzymes, (changes to the physical properties of the starch portion in the grain). Samples that achieved greater than 500 seconds (indicating the grain was acceptable, being well above the 300 second threshold) , were manually stopped. Grain was also analysed for protein, test weight, retention (barley) and screenings using a FOSS 1241 grain analyser.

Table 1. Variety characteristics and ratings for barley and wheat varieties grown in the trial.

Crop	Variety	Maturity	Quality	Awn	Sprouting tolerance
Barley	Compass	ME	^	long awns	N/A
	La Trobe	E	^	medium awns	N/A
	Fathom	VE	FEED	medium awns	N/A
	Scope CL	ME	MALT	medium awns	N/A
	Schooner	M	MALT	long awns	N/A
	Skipper	EM	^	long awns	N/A

Crop	Variety	Maturity	Quality	Awn	Sprouting tolerance
Wheat	Grenade CL Plus	EM	AH	awns	S
	Correll	EM	AH	awns	SVS
	Yitpi	M	AH	awns	MS
	Emu Rock	E	AH	awns	S
	LRPB Scout	M	AH	awns	MS
	Kord CL Plus	M	AH	awns	SVS
	Mace	E	AH	awns	S
	Halberd	M	APW	awnless	N/A

Maturity: E = early, M = mid, L = late. Sprouting: SVS = susceptible to very susceptible, S = susceptible, MS = moderately susceptible. Note: There are currently no sprouting tolerance ratings for barley. ^ Indicates barley varieties still undergoing Malt accreditation.

RESULTS AND INTERPRETATION

Did the environmental conditions influence sprouting?

Sprouting is influenced by a number of environmental factors including wind, temperature, humidity and rainfall, (with periods of wetting and drying). Figure 1 shows that after the 20mm watering, humidity and temperature were quite low, except for the spike in temperature just before the harvest date (14 November). After this period, the site received 7mm in actual rainfall, before the 20mm of 'simulated' rainfall three days later. This was also accompanied by peaks and troughs in humidity and temperature.

Multiple wetting of the grain, combined with high humidity and lower temperatures, should create an adequate environment to stimulate the germination process. Maximum temperatures were quite high over this period (before the 20mm treatment harvest), but additionally, high winds occurred the day after the first watering (20mm) and after the 7mm rain event, possibly drying out the heads very quickly.

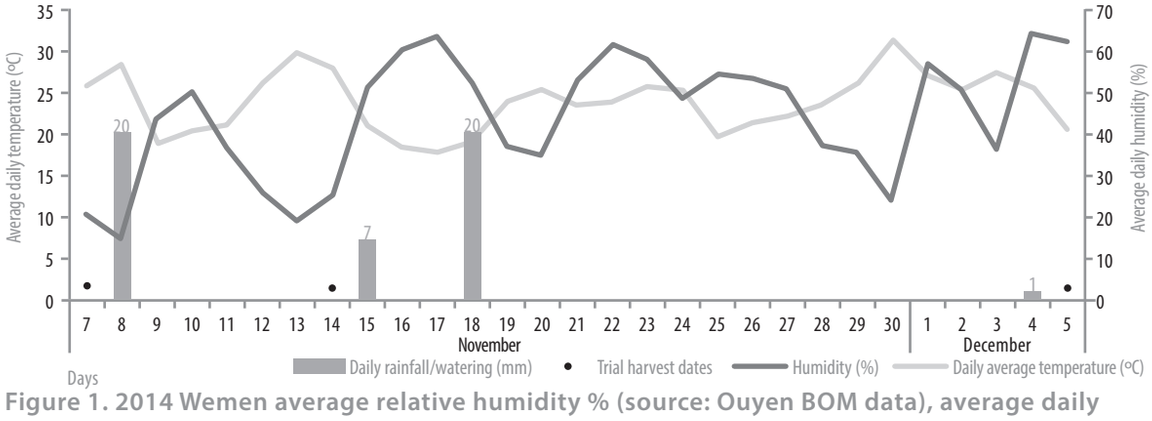

Figure 1. 2014 Wemen average relative humidity % (source: Ouyen BOM data), average daily temperature °C (source: Wemen tinytag data) and daily rainfall/simulated rainfall (mm) from 7 November to 5 December 2014.

2010 vs 2014

Substantial rainfall events during the 2010/11 harvest period resulted in nearly all crops sprouting and earning unacceptable falling numbers at grain receival sites (Figure 2). Compared with the 2014 harvest, an extra 69mm of rain was received over the same 29-day harvest period (7 November to 5 December) in the Ouyen region in 2010. As the 2010 rains occurred in thunderstorm-like events, the low temperatures, combined with high humidity, were likely to have also contributed to the decline in grain quality. However, humidity data was unable to be sourced for this report.

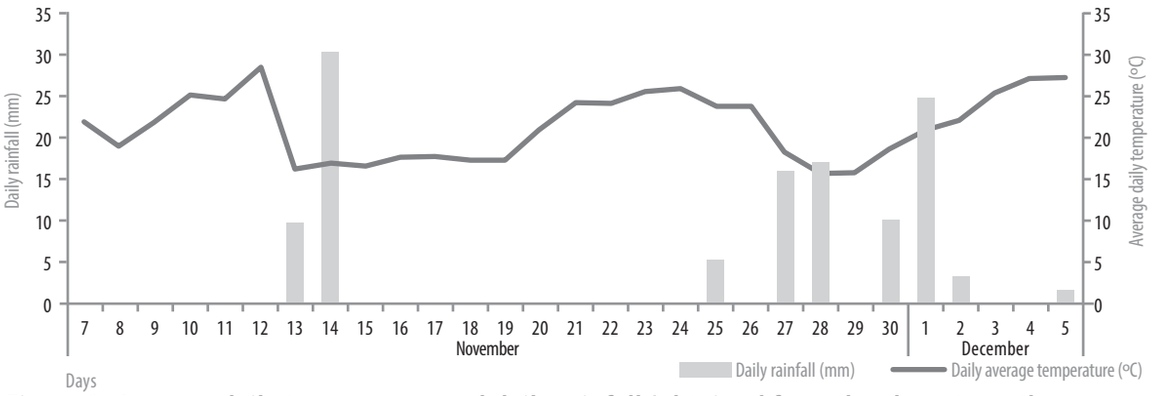

Figure 2. Average daily temperature and daily rainfall (obtained from the closest weather station at Ouyen) from 7 November to 5 December, 2010. Humidity data could not be obtained.

Did falling numbers and grain quality differ between water rates?

Falling numbers decreased in both wheat and barley as the amount of water applied increased. For all 'rainfall' treatments, falling numbers never fell below the minimum threshold (300 seconds) in wheat. Conversely, barley harvested after the 48mm was below 300 seconds. Grain quality was also affected, with test weight decreasing in both wheat and barley, and retention in barley increasing (over all the treatments). These results confirm that rewetting of the grain causes grain size to increase (or swell), and the weight of the grain becomes lighter.

Did falling numbers and grain quality differ between varieties?

Barley

The barley varieties behaved differently following the applied water treatments. Skipper, Schooner and Fathom showed greater susceptibility to sprouting, having significantly lower falling numbers (under the 300 second Malt specification) when harvested after 48mm. A falling number value under this threshold is unacceptable for Schooner (Malt) and Skipper if the variety gains Malt accreditation in 2015. Fathom is a feed variety and there is no threshold for falling numbers on feed grades.

There were interactions between falling numbers in varieties and other water rates, but differences were still within thresholds for Malt. The reduction in falling numbers may have also been influenced by the time the crop was left in the paddock after maturity. The longer the crop is left susceptible to unfavourable weather, the faster the seed's ability to protect against germination deteriorates. As the barley had reached maturity before the wheat, (but was

harvested on the same date) this may have had an influence. However, there was no trend of earlier maturing varieties showing greater susceptibility to sprouting. There was no differences in test weight and retention between varieties and varying water rates. The interaction between falling numbers and maturity and awn length was also analysed but no correlation was found.

Table 2. Falling numbers and grain quality (retention and test weight) for barley varieties at each water treatment.

Water rate	Variety	Falling numbers (seconds)	Test weight (kg/hL)	Retention (%)
0mm	Compass	502	69	79
	Fathom	505	68	72
	La Trobe	502	71	46
	Skipper	504	72	77
	Scope CL	484	70	49
	Schooner	503	71	61
20mm	Compass	471	67	77
	Fathom	465	65	68
	La Trobe	459	68	33
	Skipper	485	68	74
	Scope CL	414	67	41
	Schooner	510	69	58
48mm	Compass	302	66	83
	Fathom	267	63	79
	La Trobe	313	67	62
	Skipper	180	67	85
	Scope CL	338	66	67
	Schooner	262	68	76
	Sig. diff.			
	Variety	P<0.001	P<0.001	P<0.001
	Water rate	P<0.001	P<0.001	P<0.001
	Variety x water rate	P<0.001	NS	NS
	LSD (P=0.05)			
	Variety	18.1	0.9	6.4
	Water rate	12.8	0.6	4.5
	Variety x water rate	31.3	-	-
	CV%	5.3	1.6	11.9

Wheat

The wheat varieties did not interact differently to increasing water rates in terms of sprouting. All varieties at each treatment were above the wheat falling number standard of 300 (seconds). Interactions between variety ratings for sprouting tolerance were analysed, but ratings were not relevant in this trial. Kord CL and Correll, which are the most susceptible (SVS) to sprouting, were no different to other varieties. Interactions between maturity, architecture of the plant (awns versus awnless) and test weight were analysed, but no differences were found.

The data from this trial may provide reassurance that, in terms of sprouting and low falling numbers, wheat varieties are capable of withstanding rainfall events of up to 50mm (and

rewetting of the grain). Greater rainfall may be required for sprouting tolerance ratings to come into the equation.

Table 3: Falling numbers and grain quality (retention and test weight) for wheat varieties at each water treatment.

Water treatment	Variety	Falling numbers (seconds)	Test weight (kg/hL)
0mm	Mace	525	82
	Kord CL	502	80
	Grenade CL	501	81
	Yitpi	488	81
	Emu Rock	521	82
	Halberd	485	83
	Scout	503	82
	Correll	489	78
20mm	Mace	474	79
	Kord CL	502	77
	Grenade CL	500	79
	Yitpi	482	78
	Emu Rock	501	81
	Halberd	503	80
	Scout	464	79
	Correll	475	76
48mm	Mace	458	76
	Kord CL	462	76
	Grenade CL	472	79
	Yitpi	449	74
	Emu Rock	377	78
	Halberd	401	78
	Scout	463	76
		421	74
	Sig. diff.		
	Variety	NS	P<0.001
	Water rate	P<0.001	P<0.001
	Variety x water rate	NS	NS
	LSD (P=0.05)		
	Variety		1.1
	Water rate	22.3	0.7
	Variety x water rate	63.1	1.9
	CV%	9.4	1.7

COMMERCIAL PRACTICE

Unpredictability in weather patterns can often put growers on edge when harvest time arrives. Severe rainfall events during the 2010 harvest period resulted in pre-harvest sprouting, and cases were also reported in isolated areas in 2009 and 2011. During 2010's wet harvest, most cereal varieties (wheat and barley), regardless of their sprouting tolerance rating, had visually begun to germinate or record unacceptable falling numbers upon delivery to grain receival sites. In following years, growers have been quick to react, opting not to grow very susceptible varieties, such as Correll.

However, the findings of this trial indicate that the varieties may not be as susceptible as once thought and rainfall at harvest will not always result in sprouting or in falling numbers below minimum standards. Rainfall events greater than 50mm, with falls over consecutive days (combined with favourable weather conditions), may be more influential. Nevertheless, barley should be first priority at harvest, due to its greater susceptibility to sprouting and the added risk of lodging and head loss when harvest is delayed and rainfall occurs.

The ratings to sprouting tolerance for the wheat varieties included in this investigation were not relevant. Most varieties have some degree of susceptibility to sprouting, but the most susceptible (SVS) varieties (Kord CL Plus and Correll), of which growers may be wary, behaved in the same way as the other varieties. Despite these findings, sprouting ratings are still an important factor to consider when choosing a variety, but only when considered in addition to all other agronomic traits.

Timeliness of harvest, getting the barley off first and prioritising more susceptible and earlier maturing varieties (as they may lose seed dormancy more quickly due to longer exposure to weather) are all good strategies to reduce the risk of sprouting and grain damage in the event of an extremely wet harvest.

ON-FARM PROFITABILITY

In any season, getting your barley crop off as soon as it has ripened is a key factor in minimising risk. An additional $76/ha could be achieved by hiring a contractor to ensure Malt grain is not downgraded to Feed, in the event of severe weather events. This is a partial gross margin based on a Malt price of $276, feed price of $233, contractor price of $32/ha and average yield of 2.5t/ha.

As Schooner has shown susceptibility to sprouting in this trial, the alternative is to choose other more tolerant and newer varieties (such as Scope CL, La Trobe and Compass) but still keeping in mind agronomic and yield benefits. If Skipper gains Malt accreditation, this variety may need to be watched too.

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KEY WORDS

pre-harvest sprouting, tolerance, wheat, barley, seed dormancy, falling number, maturity, susceptibility