Pre-harvest sprouting management begins at seeding

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Key words

Pre-harvest sprouting, Falling Number, wheat quality

Key messages

- Pre-harvest sprouting (PHS) can occur prior to the wheat crop reaching harvest maturity, and the prevalence of this occurring is increased through early crop maturation (such as is caused by early [e.g. April] sowing).
- There is a large range in susceptibility to PHS in current wheat varieties, and growers should understand the risk profile (Falling Number Index rating) of a new variety before adoption.
- Growers can best manage their risk of PHS through choosing an appropriate variety (maturity and PHS susceptibility) for their sowing date, ensuring these align appropriately for their environment.

Aims

To understand how varietal susceptibility and environmental conditions during maturation interact to cause pre-harvest sprouting and low Falling Number in wheat.

Introduction

Pre-harvest sprouting (PHS) is a quality constraint to wheat production that can occur in all wheat growing areas but occurs on a sporadic basis. If a standing crop is exposed to rainfall near maturity, germination of the grain can be induced resulting in a reduction in its end-use quality. In WA, grain suspected of being affected by pre-harvest sprouting is subject to a Falling Number test, with a Falling Number of over 300 required for most milling grades.

While PHS incidence is significantly influenced by the amount of rainfall a crop receives, the severity of damage (level of germination and reduction in Falling Number) caused by this rainfall can vary markedly based on the maturation stage of the crop and the variety grown. Previous research from the Department of Primary Industries and Regional Development (DPIRD) has shown that utilising varieties with higher PHS resistance and avoiding early maturation (through appropriate sowing date and maturity type) can significantly reduce the likelihood of downgrades due to low Falling Number (DPIRD, 2021). The aim of this experiment was to better understand the relationship between maturation timing, varietal susceptibility and the conditions during the harvest period on Falling Number.

Method

Field trial and sampling

Twelve wheat varieties of varying maturity types and pre-harvest sprouting susceptibility were sown at two sowing dates (21 April and 21 May) at Gibson in 2021. The trial was sown as two sowing date blocks consisting of six banks of small plots (10m by 7 rows [0.22m row spacing]) with three replicates per variety. Summit Vigour Rich (10N-14P-10K-5S) was banded below the seed at 100kg/ha and Yaramila NPK Complex (12-5-15-8) was top-dressed at 200kg/ha. Urea (46-0-0-0) was top-dressed at 109kg/ha at six and ten weeks after sowing. Two foliar fungicides were applied in-season to manage disease, although disease was limited at this site.

Growth stages of the plots were regularly assessed, particularly targeting dates of heading (growth stage 59 [GS59]), anthesis (GS65) and physiological maturity (PM), which was estimated to have occurred when 90% of stems had lost all green colouration from the peduncle.

Grain sampling was conducted weekly from the time each variety approximately reached dough development and consisted of at least 100 heads being sampled from across the plot and dried down, first in a laboratory oven at 35°C for 24 hours and then at ambient temperature. Weekly grain sampling commenced from the April block on 30 September and on 28 October from the May block and concluded on 2 December. A final grain sample was also taken on 16 December.

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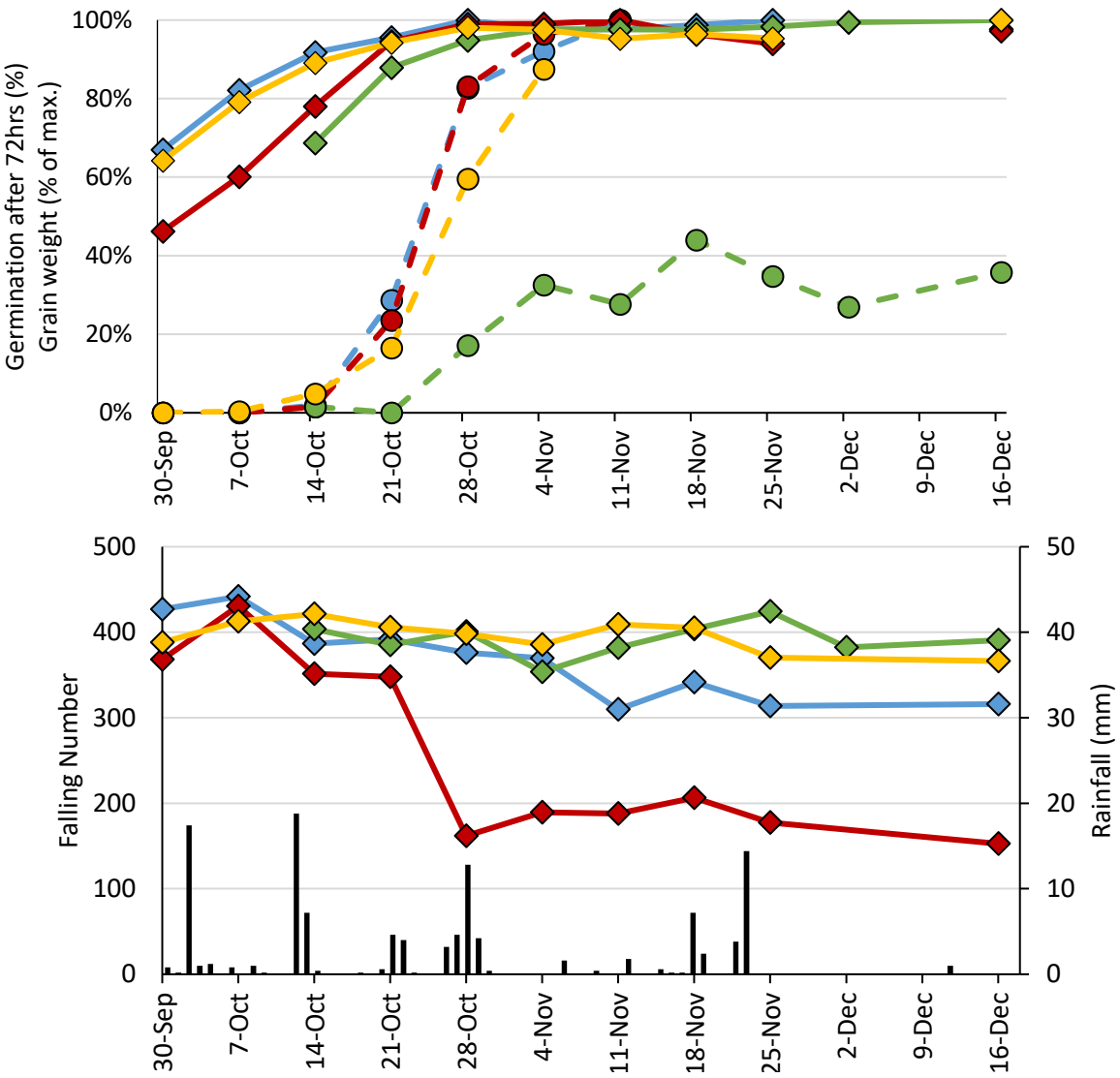

Figure 1: (Top) Grain weight (% of maximum, diamond symbols) and germination capacity (% after 72 hours, circle symbols) and (bottom) Falling Number of RockStar (Red), Scepter (Blue), Eagle Rock (Yellow) and DS Pascal (Green) sown on 21 April 2021 at Gibson and sampled weekly from dough development. Black bars denote daily rainfall (mm).

Germination tests

A subset of varieties (DS Pascal, Eagle Rock, Scepter and RockStar) were tested for germination capacity. After 24 hours at 35°C in the laboratory oven, at least five heads were gently hand-threshed to provide a grain sample. Approximately 50 grains were placed in a petri dish with two sheets of filter paper and 6mL deionised water. Petri dishes were stored on a rack above water in an enclosed container (to maintain moisture) which was kept in the dark at 20°C. Germination was assessed as the penetration of the pericarp by the coleorhiza.

Falling Number testing and grain weight

Once adequately dried, the samples were threshed in a laboratory thresher and the grain samples were stored until Falling Number testing could be completed. Grain samples were milled in a Perten Laboratory Mill 3100 to produce flour samples which were left to equilibrate for at least four hours before being tested for moisture in a Kett PR-930 moisture meter. 25ml (25.0±0.2ml) of deionised water was added to 7.0g (14% moisture basis, adjusted for actual moisture) flour and vigorously mixed for 30 seconds. A viscometer stirrer was inserted into each sample tube and they were placed into a Perten Falling Number 1700 System and the Falling Number for each sample recorded. A subsample (approx. 20g) of grain was kept and assessed for thousand grain weight (TGW) based on a 500 grain sample and for sprouted grain assessments.

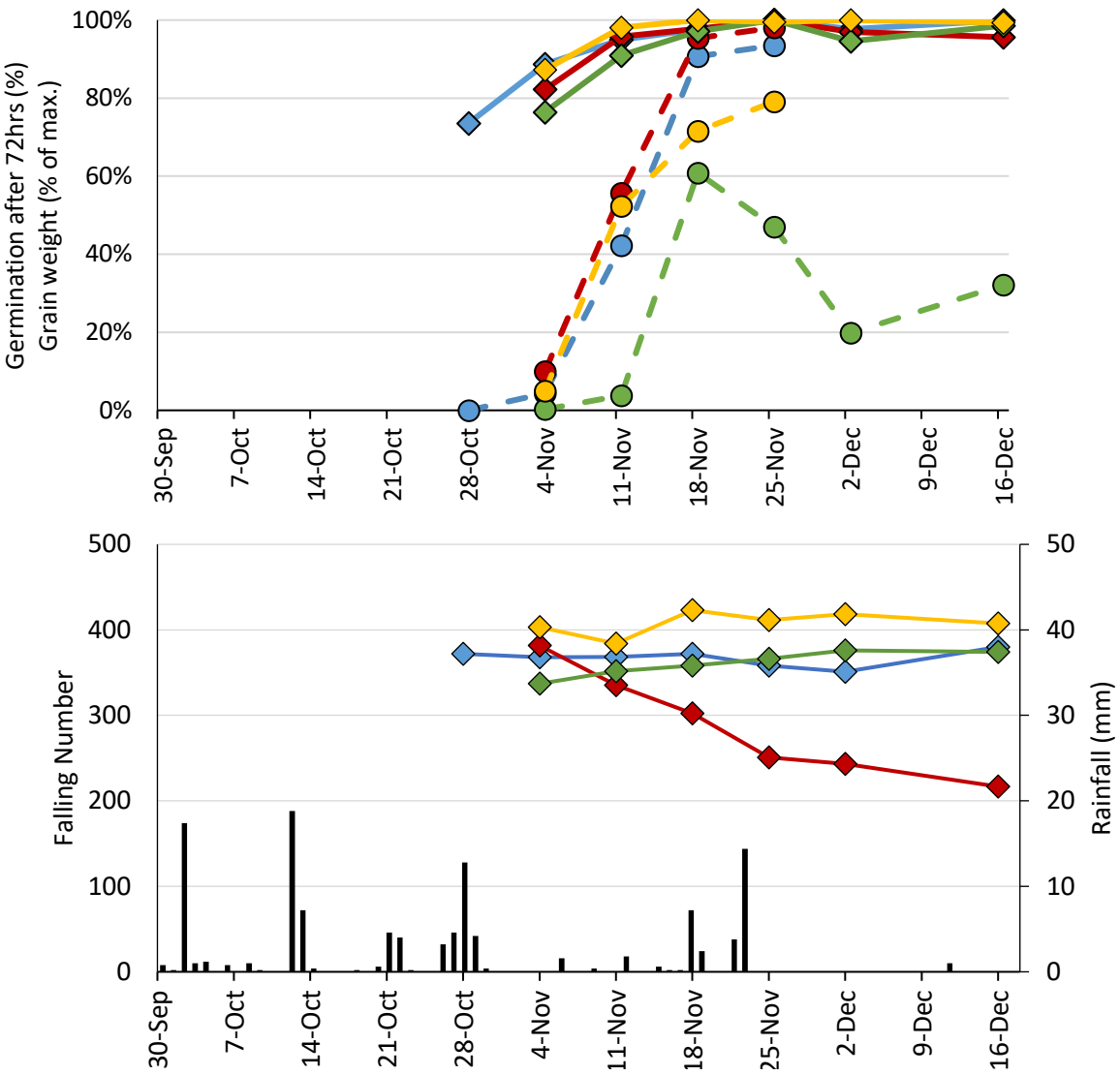

Figure 2: (Top) Grain weight (% of maximum, diamond symbols) and germination capacity (% after 72 hours, circle symbols) and (bottom) Falling Number of RockStar (Red), Scepter (Blue), Eagle Rock (Yellow) and DS Pascal (Green) sown on 21 May 2021 at Gibson and sampled weekly from dough development. Black bars denote daily rainfall (mm).

Results

Grain weight and germination capacity

Visual assessments of crop colour were used to provide an estimated date of physiological maturity, with the April sown Eagle Rock and Scepter having estimated dates of physiological maturity of 23 and 24 October, respectively. Interestingly, despite being a longer maturity variety based on flowering date (12-13 days longer duration to flower from April sowing), RockStar reached estimated physiological maturity just four days after Scepter (28 October). Grain weight data correlated well with these estimates (Figure 1), with all three varieties reaching 98-100% of their maximum grain weight by 28 October (from 94-96% on 21 October). DS Pascal, which flowered on the same day as RockStar, matured more slowly, reaching physiological maturity on 2 November and 98% of maximum grain weight by 4 November.

The germination capacity (% germination after 72 hours) of Eagle Rock, Scepter and RockStar all significantly increased in the two weeks prior to and one week following physiological maturity, with all three varieties increasing from almost nil to over 85% germination in this time (Figure 1). While the germination capacity of DS Pascal also increased from two weeks prior to physiological maturity, it did not exceed 50% germination within the sampling period.

Compared to the April sown block, the May sown block matured relatively quicker, with all four varieties increasing from approximately 80% to 100% of maximum grain weight within two weeks, although the relative dates of maturation were similar (Figure 2). Maximum grain weight aligned well with their estimated

dates of physiological maturity of 11 November (Eagle Rock), 13 November (Scepter), 15 November (RockStar) and 19 November (DS Pascal).

May sown Scepter and RockStar increased from less than 10% to over 90% germination capacity (after 72 hours) within two weeks around maturation (4 November to 18 November). Eagle Rock showed a similar increase although did not exceed 80% germination capacity in November (testing of Eagle Rock ceased after 25 November). Despite showing an increase in germination capacity on 18 and 25 November (the cause of which is yet to be determined), DS Pascal generally showed low germination capacity (below 40%) throughout the sampling period.

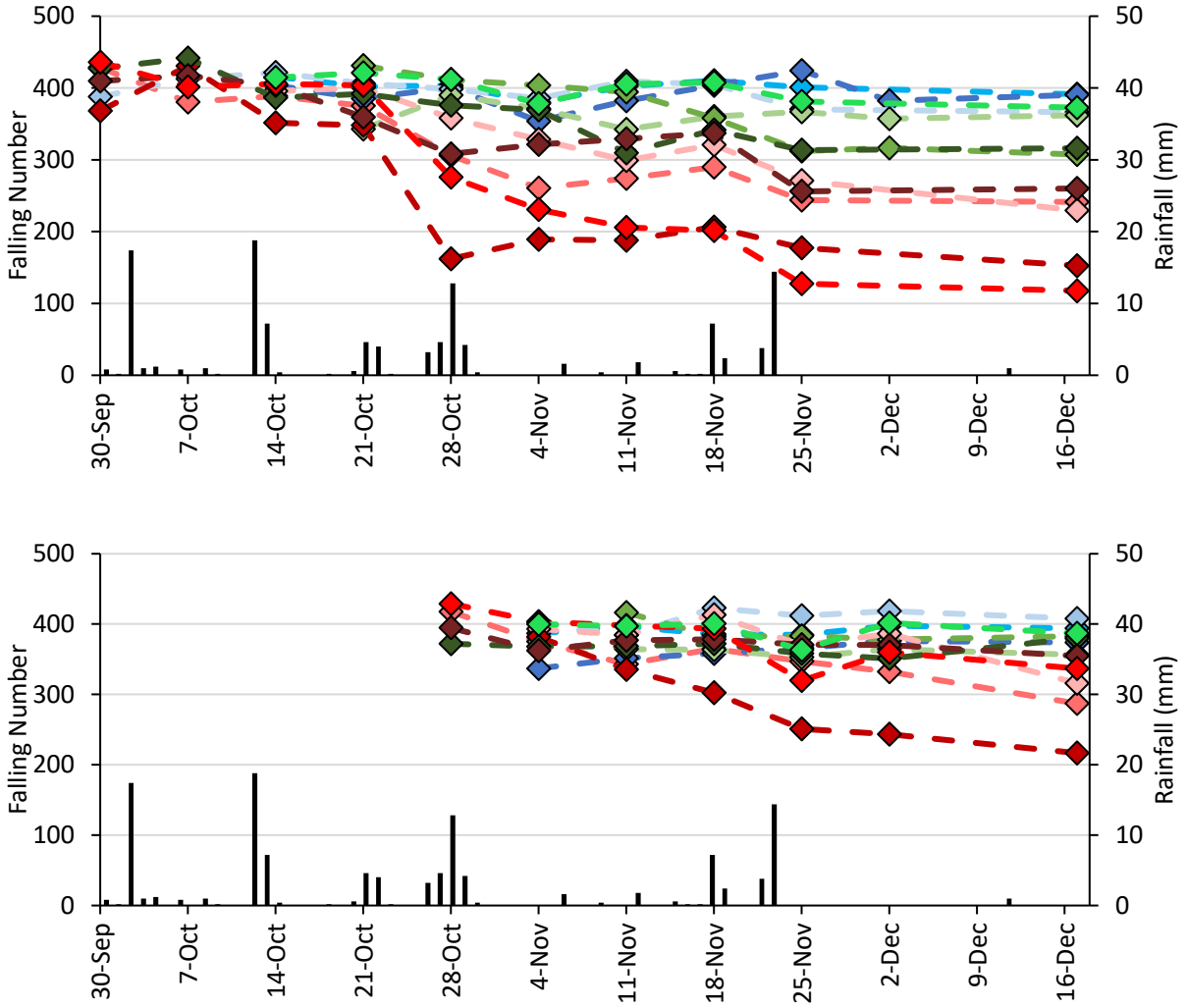

Figure 3: Falling Number of twelve wheat varieties sampled weekly from dough development when sown on (top) 21 April 2021 and (bottom) 21 May 2021 at Gibson. Varieties are coloured based on their Falling Number Index, with red and pink indicating varieties rated 2-3, green varieties rated 5, and blue varieties rated 6 or above.

Falling number

Despite similar maturation dates and germination curves between Eagle Rock, Scepter and RockStar, the Falling Number testing showed vastly different responses across the harvest period. Following a tested Falling Number in excess of 300 seconds in the first three weeks of October, rainfall in the week preceding the 28 October sampling date resulted in significant sprouting and a drop in Falling Number of April sown RockStar to less than 200 seconds. There were no significant changes at later sampling dates. While April sown Scepter did show some decline in Falling Number in response to rainfall in the harvest period, changes were gradual and less significant and its Falling Number remained above 300 seconds at all sampling dates. There was no significant change in the Falling Number of April sown Eagle Rock throughout the harvest period, nor for DS Pascal which did mature slightly later than the other varieties.

Given none of the four varieties when sown in May showed any discernible germination capacity during October, the late October rainfall did not cause any sprouting in these varieties. May sown RockStar did show some gradual reduction in Falling Number in response to rainfall during November (dropping from above 350 seconds to below 250 seconds), while the other three varieties did not change in Falling Number significantly.

The eight other varieties sampled at the site varied significantly in their maturation timing, from Vixen, which matured on 15 October and 8 November from the April and May sowing dates, respectively, to Illabo, which matured on 13 and 19 November at the two sowing dates (data not shown). Although germination testing on these varieties was limited, historically very few of them have shown notable grain dormancy and it is expected that their germination capacity would have peaked near physiological maturity (as per Scepter, RockStar and Eagle Rock).

Given the large differences in their maturation timing and pre-harvest sprouting susceptibility, the responses of these varieties in terms of Falling Number across the sampling period varied significantly (Figure 3). However, their responses generally aligned with their PHS susceptibility as determined by the Falling Number Index ratings produced by DPIRD. Of the five varieties with a Falling Number Index of 2 or 3 (susceptible to very susceptible to PHS), none maintained a Falling Number in excess of 300 past 18 November from the April sowing date. In comparison, none of the varieties rated 5 or above (generally low susceptibility to PHS) showed a Falling Number of less than 300 at any of the sampling times. From the May sowing block, no variety except RockStar showed a Falling Number of below 300 at any sampling date.

Conclusion

Exposure to rainfall is the primary driver of pre-harvest sprouting and reduction in Falling Number, however, the response of a crop to this rainfall is significantly influenced by its maturation stage and the pre-harvest sprouting susceptibility of the variety grown. This 2021 trial involved weekly sampling (from dough development to post-maturation) of wheat varieties from two sowing dates. The results of this trial support previous DPIRD research whereby pre-harvest sprouting risk was increased through early maturation (from sowing date and maturation length). Although varieties differed significantly in their Falling Number in response to rainfall in the harvest period, differences could not be explained by germination capacity, supporting the need for field-based assessments of Falling Number risk (as opposed to sole reliance on grain dormancy testing alone) to incorporate other phenotypic differences that drive PHS risk.

When managing PHS, growers should understand that earlier maturation (through early sowing and maturity types) is likely to increase their risk of downgrades due to PHS and when sowing in April, growers should target longer maturity varieties with increased PHS resistance (a higher Falling Number Index). Further work is required to understand the driver of this increased risk from early maturation, with the increased prevalence of cool and wet conditions during maturation and the influence of this weather on the dry-down and grain dormancy loss of wheat crops likely to play a role.

References

DPIRD (2019), Wheat grain quality – falling number and pre harvest sprouting resistance, Available at: https://www.agric.wa.gov.au/wheat/wheat-grain-quality-falling-number-and-pre-harvest-sprouting-resistance.

Acknowledgments

This research is undertaken with the support of DPIRD's Crop Sowing Guide project and the author would like to acknowledge the support of the breeding companies in this work. For more information about this trial, please contact Jeremy Curry (Jeremy.curry@dpird.wa.gov.au or 08 9083 1160).