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Stubble Olympics: the cereal pathogen 10 cm sprint – growth patterns of crown rot, common root rot and yellow leaf spot fungi in post harvest cereal stubble.

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Key findings

- The pathogens that cause cereal diseases such as crown rot (CR), common root rot (CRR) and yellow spot (YLS) can grow within cereal stubble after harvest under high humidity. Inoculum levels in cereal stubble can increase above harvest levels in wet weather.
- The levels of disease resistance to CR, CRR or YLS in the varieties and crops tested do not appear to slow or limit pathogen growth after harvest, and therefore did not influence post harvest inoculum accumulation. However, variety and crop selection for disease resistance in-crop is still a useful disease management strategy.
- In stubble with 100% relative humidity (wet/rainy/foggy/dewy weather), the CR fungus progressed fastest (1 cm/day) with the YLS pathogen the slowest (0.4 cm/day). This is likely to influence which pathogen dominates in following seasons if there are mixed infections in the same crop.
- A reduction in cereal stubble biomass might limit CR, CRR and YLS growth after harvest in stubble and reduce the amount of inoculum carried forward. Options could include selecting low-biomass varieties, low harvest heights or cutting for hay, but field validation is required.

Introduction

Fusarium crown rot, YLS or tan spot and CRR are important stubble-borne cereal pathogens. The diseases these pathogens cause are very difficult to control in cereal stubble-retention systems as the inoculum is preserved in the previous years' cereal rows. Not much is known about what these pathogens do in the stubble after harvest of an infected crop, except that they generally persist long enough to cause disease in following seasons.

Reports of pathogen growth in post harvest cereal stubble, also known as saprophytic growth (i.e. growth on dead or decaying matter), has been reported, but it is still unclear if this growth contributes to inoculum build-up or disease risks in future cereal crops. Saprophytic growth of CR can be rapid (1 cm/day) in cereal stubble if moisture is not limiting (Petronaitis et al., 2020). But how much moisture do we need for saprophytic growth to start, and is it the same for other pathogenic fungi such as *Bipolaris sorokiniana* (CRR causative agent) and *Pyrenophora tritici-repentis* (YLS causative agent) in different cereal stubbles?

Knowing how these pathogens behave in post harvest cereal stubble could be the key to controlling them effectively in conservation agriculture systems. To answer these questions an experiment, named the Stubble Olympics was set up, to explore the following questions:

1. What moisture conditions induce saprophytic growth in these different pathogens?
2. How far and fast will inoculum progress under such conditions?

3. Can crop selection or other management strategies be used to suppress saprophytic growth?

The Stubble Olympics experiment

Treatments

The contestants in the Stubble Olympics are two isolates each of *F. pseudograminearum*, *B. sorokiniana* and *P. tritici-repentis*. Each isolate was placed inside individual tillers of cereal stubble from four crop types (Table 1). Each was then tested for saprophytic fitness by measuring their growth under controlled moisture conditions ranging from 90% to 100% relative humidity (RH) in 2.5% RH increments. Two varieties of bread wheat and two varieties of barley were selected as having either a relatively susceptible or relatively resistant disease rating for each pathogen.

Table 1 Cereal stubble collection variety information and disease ratings for CR, CRR and YLS. Rating information from *Winter crop variety sowing guide 2019* (Matthews and McCaffrey, 2019).

Cereal species	Variety (class)	Crop location	CR rating	CRR rating	YLS rating
Bread wheat	EGA Gregory (APH)	Narrabri	S	MS–S	S
	LongReach Lancer (APH)	Narrabri	MS–S	S	MR–MS
Durum wheat	DBA Lillaroi (ADR)	Tamworth	S–VS	MS–S	MR–MS
Barley	Compass	Narrabri	S	MS	NA
	Rosalind	Narrabri	MS–S	S	NA
Oat	Eurrabie	Narrabri	NA	NA	NA

Abbreviations: Australian prime hard (APH), Australian premium durum (ADR), not applicable (NA), moderately resistant (MR), moderately susceptible (MS), susceptible (S), very susceptible (VS).

Method

Individual tillers were inoculated at the base with an agar plug with one of the six pathogen isolates. The tiller end was inserted onto a metal nail plate to simulate standing stubble. Humidity chambers (Figure 1) were run for 7 days at constant temperature (25 °C) under alternating ultra-violet light (12-hour light/12-hour dark). Saprophytic growth was measured as the number of tiller segments (1 cm length) and positions (1–10) the pathogen was recovered from the agar.

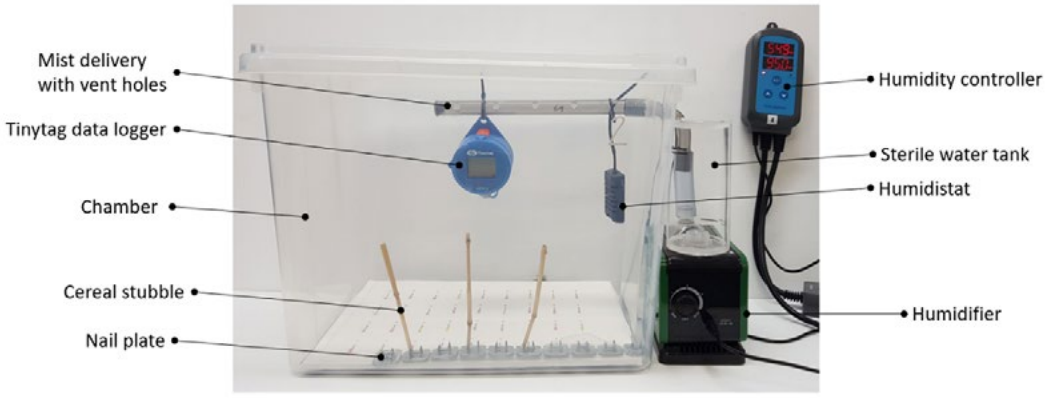


Figure 1 Example of controlled humidity chamber design containing standing stubble.

Experiment design

- Two replicates over time.
- Split-plot design.
- Relative humidity (RH) treatments main plots.
- Crop, variety, pathogen, isolate combinations were sub-plots.

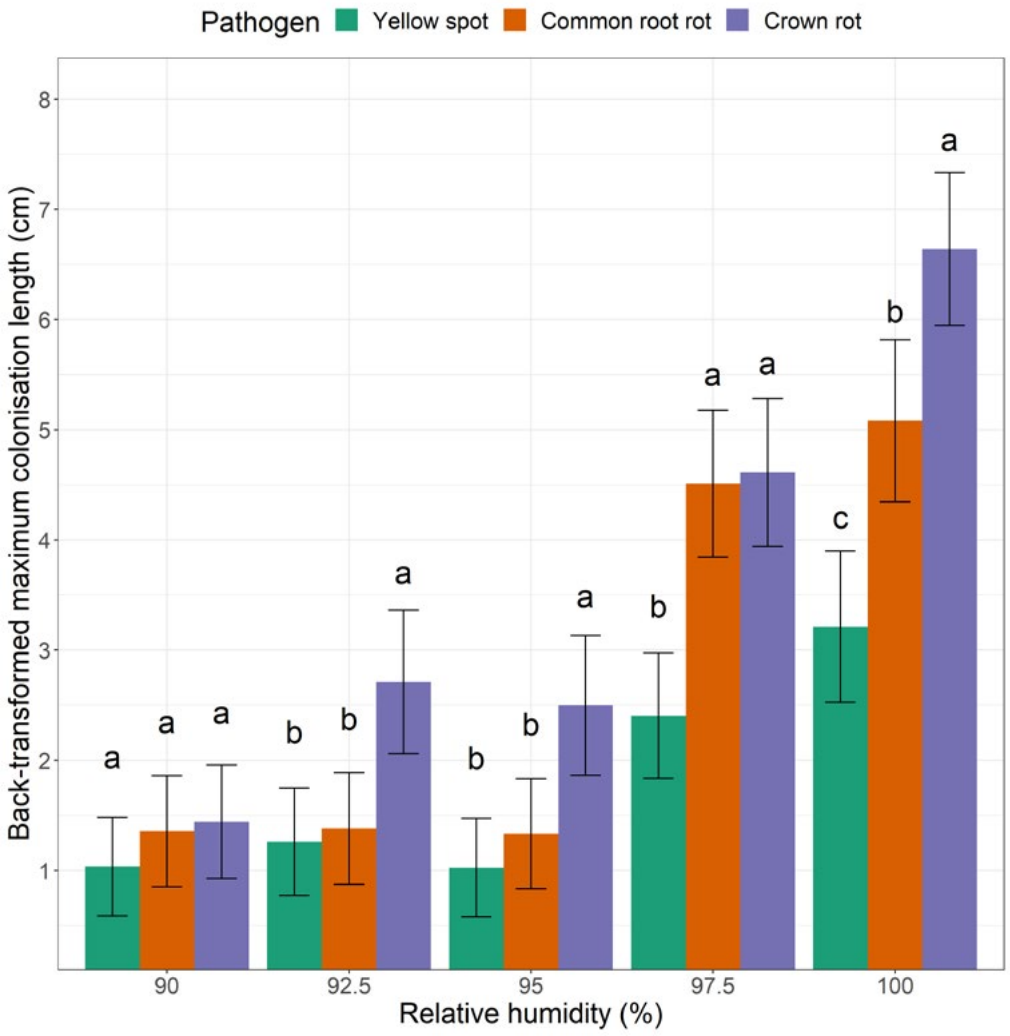
Location

Tamworth Agricultural Institute, controlled temperature room.

Results

Moisture induces saprophytic growth of pathogens in cereal stubble

Moisture (i.e. RH) had a profound effect on the saprophytic growth of all three of cereal pathogens (Figure 2). In general, all pathogens grew further within stems as moisture increased, with little to no growth occurring in the driest treatment (90% RH). Once the moisture was increased to 92.5% RH and 95% RH, the CR pathogen was able to colonise stubble twice as fast as the other two pathogens. The YLS and CRR fungi required moisture levels of 97.5% to progress significantly. The saturated (100% RH) treatment produced the greatest growth up the stubble and the most inoculum. Differences between isolates were not significantly different ($P = 0.05$), so the mean of both isolates are presented.



Note: LSD letters only enable comparisons between pathogens within a humidity treatment (not between humidity treatments). Values with the same letter are not significantly different (P=0.05).
Error bars represent approximate standard error of the mean.

Figure 2 Maximum colonisation (cm) of cereal stubble by three cereal pathogens subject to different moisture conditions for seven days.

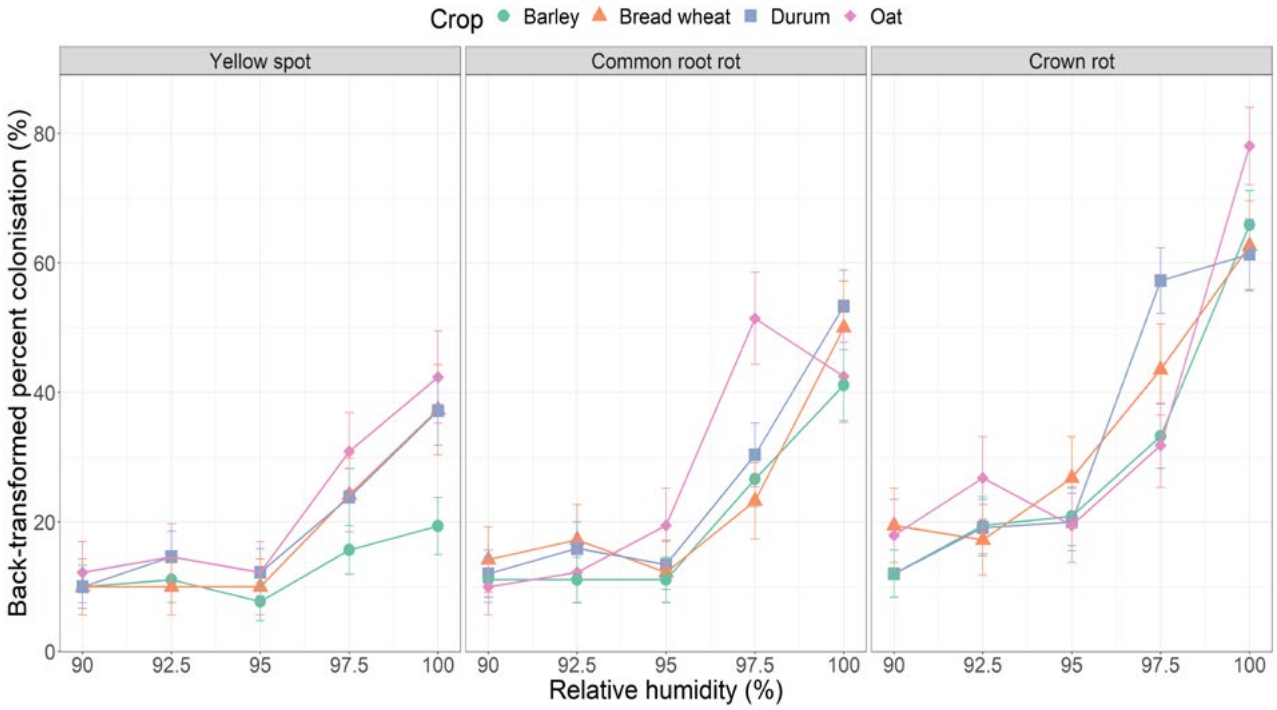
Inoculum progressed most rapidly under moist conditions (which pathogen will take home the gold?)

At 100% RH, the CR pathogen grew significantly faster than the other two pathogens (~1 cm/day – takes home the gold!), while CRR was significantly faster (~0.7 cm/day – silver!) than YLS (~0.45 cm/day – bronze!) (Figure 2).

Multiple-pathogen infections (e.g. CR +CRR) are common in the northern region (Simpfendorfer and McKay, 2019), so it is possible that under saturated conditions (i.e. rainy, dewy or foggy weather) the CR pathogen could rapidly colonise pre-infected stubble, making the disease more likely to dominate in following seasons.

Selecting crops for resistance won't help suppress growth in the saprophytic phase

There were no differences in pathogen speed of progression (cm) (Figure 2) or the percentage of inoculum remaining (Figure 3) between two varieties of the same crop type, regardless of the resistance rating (Table 1). This suggests that varietal resistance does not reduce saprophytic growth (i.e. inoculum production) post harvest.



Differences between varieties of the same crop type were not significantly different ($P = 0.05$).
The mean of two varieties of bread wheat and barley are presented.
Error bars represent approximate standard error of the mean (P=0.05).

Figure 3 Inoculum produced by three cereal pathogens in different cereal stubble, as a percentage (%) of total stubble length colonised after seven days.

Oats, and barley have no resistance ratings for the selected diseases because they are not considered important hosts. The three disease pathogens produced the same or more inoculum on oat stubble at 100% RH (Figure 3). The YLS pathogen produced significantly less inoculum on bread wheat stubble (a recognised host) under moist conditions compared with the non-host oat ($P = 0.05$). Oat stubble might allow pathogens to progress faster as it has a less dense/hollow stem and a higher nutrient content (i.e. lignin) than wheat or barley. Even if there are only low levels of infection in the growing season, or the disease is not expressed due to favourable seasonal or plant tolerance, there can still be rapid colonisation saprophytically post harvest.

How may this knowledge be important to growers?

Harvest height to manipulate stubble biomass – still a work in progress

Lowering harvest height is a quick way to reduce standing cereal stubble biomass (Figure 4). This could be useful in severely infected paddocks by removing disease inoculum and/or limiting the amount of vertical stubble available for further saprophytic growth. In severe cases, such as CR-affected durum wheat in a dry season, the stubble might already contain high levels of the CR pathogen at harvest (Figure 4). Field testing is underway to determine if saprophytic growth is problematic in taller

stubble with increased inoculum levels after harvest. In addition, the ability of shorter stubble to limit saprophytic growth will be tested as a possible management strategy.

Durum wheat harvested at three heights: 10–15 cm (A), ~30 cm (B) and 40–45 cm (C).
Far right: recovery of CR pathogen (red–brown colonies) shows significant colonisation within the stem at harvest (up to 30 cm). Arrows indicate where the pathogen was recovered from along the stubble length.

Figure 4 Harvest-height disease management experiment.

Modelling saprophytic growth based on weather patterns/predictions – we're in the early days

A constant 25 °C temperature in the humidity chambers enabled a detailed investigation into the pathogen's response to moisture in stubble. Modelling saprophytic growth in the field would require knowledge of pathogen growth patterns across a range of temperatures. This is because the amount of water the air holds (total water) changes with temperature (more water at higher temperatures) even if the RH stays the same. Air gives up moisture more freely at lower temperatures as the dew point is lower, leading to more dewy/frosty or foggy mornings during winter. Determining whether the pathogens respond to total water or dew point/RH or both will be essential for modelling saprophytic growth.

Should growers be concerned about saprophytic growth of pathogens in cereal stubble?

The short answer: be alert, not alarmed

We are still trying to be understand if and how cereal pathogen saprophytic growth during fallow and non-host rotation affects disease risk in following seasons. It is possible that the recent high rainfall in many areas could have spiked pathogen levels before sowing, placing new crops at a higher risk than in previous, drier years. The extended dry conditions (2017–19 seasons) have allowed inoculum to persist at damaging levels for two to four seasons as stubble has not broken down. Be vigilant about checking this years' cereal crops for disease symptoms and consider appropriate in-crop management strategies if necessary.

Seasonal conditions can affect cereal stubble biota, both good and bad, during fallows and non-host rotations, with stubble not being dormant during these times.

Conclusions

Dry conditions: allow inoculum and cereal stubble to persist longer in paddocks, as beneficial microbes that suppress pathogens and promote stubble decomposition require high moisture to be effective. The CR pathogen is especially suited to survival and growth in drier conditions.

Wet conditions: can potentially increase inoculum (such as those applied in this study), but cereal stubble will also decompose faster in prolonged wet weather. Moisture can increase the activity of beneficial microbes, helping with stubble decomposition and pathogen suppression. Moist conditions also stimulate these pathogens to produce spores, which can persist in soil for many years even when there is no stubble (e.g. conidia of CRR pathogen).

PREDICTA® B testing is a very effective method for determining paddock disease risk if the correct sampling protocols are followed. If your paddock/s returns a low risk or below detection level in the PREDICTA® B test, continue following best practise agronomy for the next cereal crop.

Acknowledgements

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References

Matthews P and McCaffrey D (2019). *Winter crop variety sowing guide*. NSW Department of Primary Industries, pp. 20–65.

Petronaitis T, Forknall C and Simpfendorfer S (2020). Crown rot stubble inoculum levels within season and further growth after harvest. *Northern NSW research results 2019*, pp. 87–91. NSW Department of Primary Industries.

Simpfendorfer S and McKay A (2019). What pathogens were detected in central and northern cereal crops in 2018? *GRDC Update, Goondiwindi*, pp. 106–115.

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