Crop protection

Southern NSW paddock survey – 2014 to 2016

Dr Andrew Milgate, Tony Goldthorpe and Brad Baxter (NSW DPI, Wagga Wagga)

Key findings

- The frequency of winter cereals in the rotation have a large impact on crown rot inoculum build up.
- Monitoring paddocks over time is a powerful way to help crown rot management and the PreDictaB™ soil tests are an effective method for achieving this.
- The dominant wheat–canola rotation in southern NSW is increasing the region's level of risk to losses caused by crown rot.
- Not all paddocks behave the same way and factors other than crop type are affecting crown rot behaviour.

Introduction

This report describes some of the findings to date of a longitudinal survey of soil and stubble-borne diseases in southern NSW (sNSW) farming systems. In total, 93 representative paddocks are being monitored as a part of the study when in their cereal phase. We will focus specifically on the crown rot inoculum in this report.

Fusarium pseudograminearum (Fp) and *Fusarium culmorum* (Fc) are the two most common causal agents of the crown rot disease. Crown rot restricts the flow of water and nutrient through the xylem resulting in stress during the critical grain-fill stage. This can result in pinched grain or heads with no grain, otherwise known as whiteheads. Crown rot infects winter cereals only, including barley, bread wheat, triticale and durum wheat in order of decreasing tolerance to the pathogen.

Crown rot is favoured by wet, cool winters and dry, hot spring conditions. It can be identified early in the growing season as stunted yellow plants or single dead tillers. More reliable identification can occur in periods of moisture stress – typically, honey-coloured stem browning extending from the sub-crown internode upwards to the first or second node. As opposed to take-all, where all tillers on a single plant will express whiteheads, crown rot will cause whiteheads in scattered single tillers. Yield loss can still occur without the expression of whiteheads.

The incidence of crown rot in sNSW farming systems has been increasing over the past decade. However, before this study, no replicated systematic surveys had been conducted in the region to inform industry of the extent of the issue. This study serves to identify the crown rot risk to the industry and link with research on rotation impacts and grower practice at a whole-paddock scale.

Methods

Soil and stubble samples were collected, starting at a permanent GPS location, sampling from the centre moving outwards in a spiral pattern. Ten soil cores and 10 pieces of stubble were collected at 10 points along the spiral. The samples were bulked, homogenised and a sub sample taken for analysis. The sub sample comprised 500 g of soil and 30 random pieces of stubble 4–5 cm long, ensuring the crown was present on the stubble.

The samples were then analysed using PreDictaB™, which estimates the amount of a pathogen present in the soil and stubble by DNA analysis. In this instance, Fp and Fc are the main focus, however, various other cereal, oil seed and pulse diseases can be identified during the DNA assay process.

Results and discussion

Crown rot was present in 55% of the paddocks surveyed in 2014 and 80% of paddocks in 2015. Pre-sowing data shows that 63% of the 2016 paddocks sampled had crown rot present. However, due to the favorable season for crown rot, this number is likely to increase when the postharvest PreDictaB™ data is available. Our data indicates that crown rot increased throughout the growing season in paddocks that had crown rot before sowing.

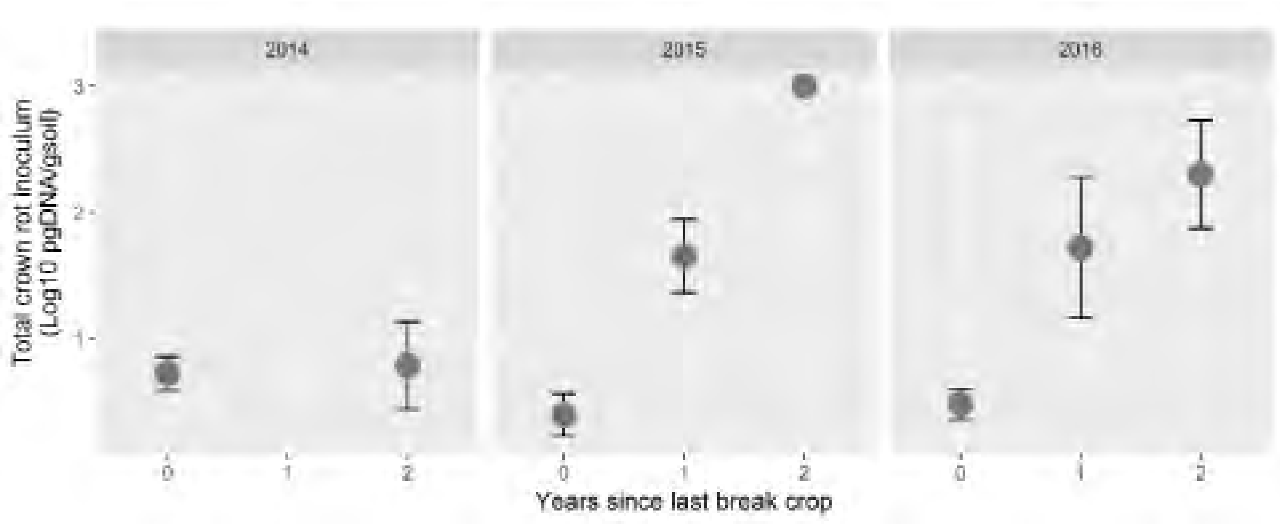

Figure 1. Number of years since a non-cereal break crop's effect on pre-sowing levels of crown rot (Fp + Fc) before sowing 2014–2015, measured by PreDictaB™ analysis. Log risk levels: below detection = <0.6, low = 0.6–<2.0, medium = 2.0–<2.5, high = ≥2.5 for bread wheats in southern NSW.

Topographic, climatic and human factors can influence variability in Fp and Fc inoculum build up. These can include: soil type, rainfall amount and timing, seasonal temperatures, agronomic factors, variety selection, crop rotations, break crop duration, weed control, stubble retention, cultivation and stubble burning.

Previous crop effects and risk factors

The survey has revealed clear trends in grower paddocks and the impact of choices in crop type. Figure 1 clearly shows that even after one year of winter cereal, the level of inoculum increases significantly and this continues to rise in subsequent years of continuous cereal crops. This trend is in line with research results. What is important to point out, is that this result comes directly from current grower practices in southern NSW.

It is well established that host crops such as wheat, allow for the build up and maintenance of inoculum levels. Approximately half of the paddocks surveyed pre-sowing were in the medium and high risk categories for crown rot following a cereal crop, (Figure 1). This translates to a potential yield loss of between 5–60% if a cereal crop is grown (McKay et al. 2015).

The number of years since sowing a break crop between cereals can significantly influence the amount of inoculum within a paddock. A break crop can include any crop that is not a cereal. Pulses and oil seed crops are common examples. Figure 1, shows the significant rise in the crown rot risk as the number of years of continuous cereal increases.

The first cereal crop sown following a break crop (0 years) has a significantly reduced crown rot risk compared with those sown after one or two cereal crops. The first year following a break crop (0 years), essentially has a risk factor of below detectable level, which results in a 0–5% potential yield loss (McKay et al. 2015). One year since a break crop, or two consecutive cereal crops, increases the risk to a low–moderate risk – a 0–30% potential yield loss (McKay et al. 2015). Two years since a break crop, or three consecutive cereal crops, increases the crown rot risk to high. This could potentially result in a 15–60% yield loss under the right conditions. This estimate is based on bread wheat in sNSW; the risk factor for durum wheat is significantly higher.

The potential yield loss underlies the importance of using break crops in a rotation to manage crown rot inoculum. If high levels of inoculum are present, one, two or more years in a fallow, pulse or an oil seed crop might be needed to bring the inoculum levels down to a suitable point to allow cereals to be sown without the increased risk of economic loss.

The survey is beginning to reveal the impact that non-host crops can have on crown rot inoculum levels. The box plot in Figure 2 shows that wheat and canola are the most frequent crops within the surveyed paddocks. There is a large variation in the amount of inoculum present within these paddocks (Figure 2). Paddocks that were sown in the previous year to canola have, on average, lower inoculum levels, but the range of values is similar to the paddocks sown to wheat.

The unexpected high level of inoculum persisting in some canola paddocks requires further examination. In this report we have only considered the immediate previous crop effect on crown rot inoculum in Figure 2. If additional rotation years are taken into account, we would expect to identify crop sequences that are associated with these phenomena. However, our preliminary analysis of two years of rotations did not reveal any obvious trends and will need more data and analysis to identify potential causes (data not shown).

The dominance of wheat and canola in the sNSW rotations means there is not yet enough data to draw conclusions on the impact of other crop types. However, the patterns displayed thus far support the existing research results that non-host species such as lupins reduce crown rot risk significantly.

Paddock specific trends

The survey is providing the clear result that not all paddocks behave in the same manner over time. This is due to the complex interactions occurring between soil, rainfall, rotation and pathogen. The cooperators treat all paddocks within the survey set differently. However, some paddocks show interesting inoculum trends based on similar rotations, but have different location, topographic and climatic characteristics.

The inoculum levels of the four paddocks shown in Figure 3, are typical of sNSW farming systems. Each paddock comes from a mixed farming enterprise with a focus on both cropping and livestock. These paddocks have pasture, wheat and canola rotations.

There was a rapid buildup of crown rot in paddock 6 over the three-year period with a continuous winter cereal rotation (Figure 3). Inoculum levels in this paddock increased from a low risk before sowing in 2014 to a high risk within the season. This risk level translates to a potential yield loss of 15–60% (McKay et al. 2015) for the 2015-sown wheat crop.

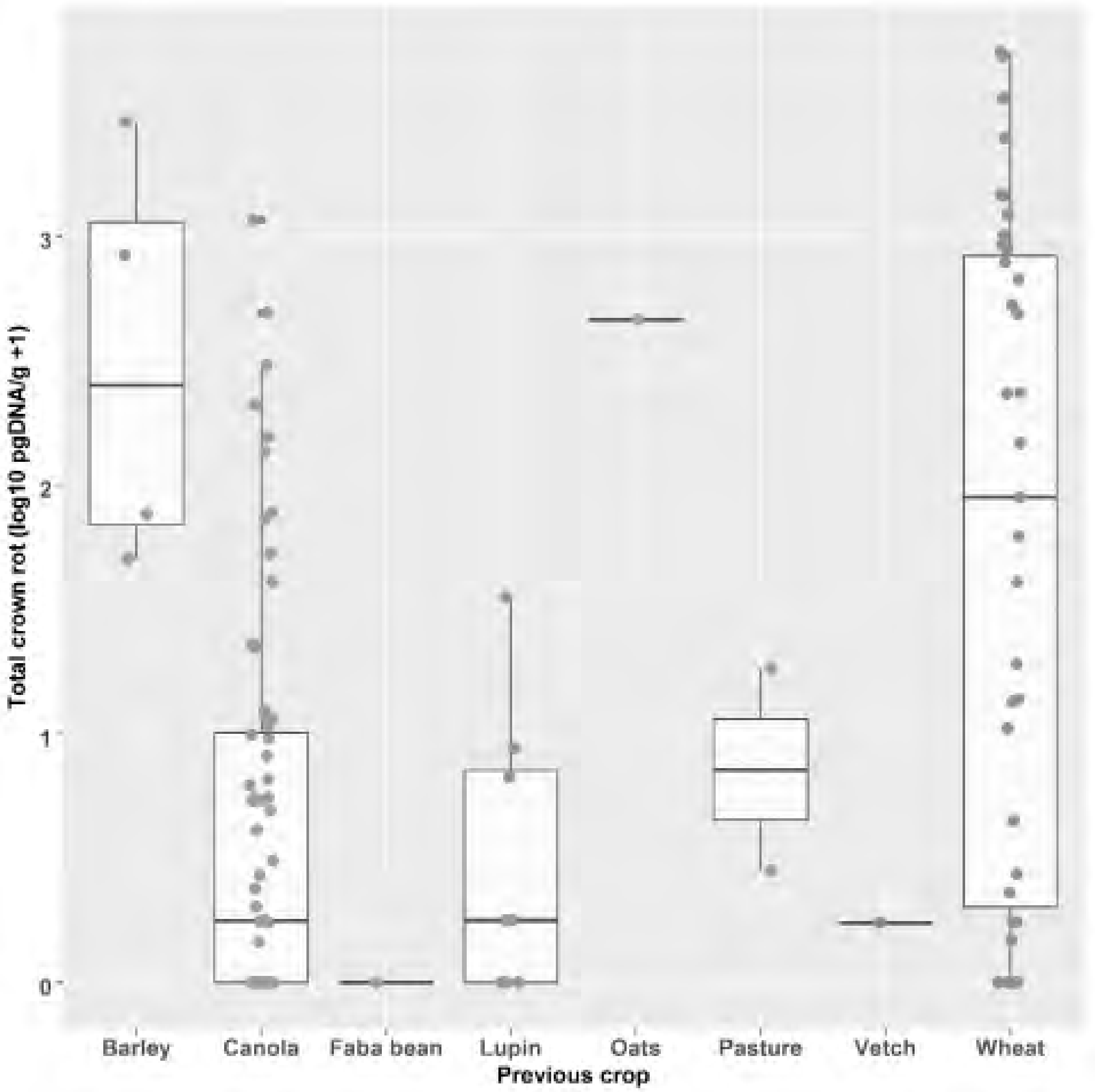

Figure 2. Previous crop effects on the background levels of total crown rot inoculum (*Fusarium pseudograminearum* and *Fusarium culmorum*) before sowing 2014–2016 measured by PreDictaB™ analysis in 120 paddocks from southern NSW. Log risk levels: below detection = <0.6, low = 0.6–<2.0, medium = 2.0–<2.5, high = ≥2.5 for bread wheats in southern NSW.

The inoculum survived over the 2014–2015 and 2015–2016 summer, which then resulted in a high risk starting level for the 2015 and 2016 wheat crops. In this instance, the paddock had reached a high level and continued to maintain the levels of inoculum expected with repeated sowing of susceptible crop species.

The inoculum levels of paddock 33 (Figure 3) had a similar trend to paddock 6. The paddock started at below detectable levels of crown rot in 2014 through to a high level before sowing in 2016. Paddock 33 has a very different soil type; heavier and typical of gilgai soil types compared with the lighter red, clay loams of paddock 6. Inoculum levels in paddocks 6 and 33 are typical of the steady increase in inoculum in a cereal-on-cereal rotation.

The increase in crown rot inoculum in paddocks 3 and 11 are not typical of the usual increase patterns. Paddock 3 was sown to three consecutive wheat crops from 2014 to 2016. However, the crown rot levels remained below detectable–low levels.

The low levels of crown rot in paddock 3 over the three years are not typical and might be explained by the grower adopting an integrated approach to disease management through using a combination of sowing a moderately susceptible wheat variety, burning stubble and inter-row sowing. Sowing cereal-on-cereal for three consecutive years is not advised. Further measuring of inoculum in this paddock and others with similar management will be conducted over the next two years.

There was a rapid buildup in inoculum in paddock 11 during the growing seasons 2014–2016 and a rapid decline over each summer. This paddock has heavy, grey clay typical of river flats. The increase during the growing season and then the decline over summer could be attributed to interactions between rainfall, soil type and agronomic practices.

These paddocks highlight that growers need to understand how their own paddocks are responding to the interaction with stubble-borne diseases and that the PreDictaB™ test provides a tool to do this.

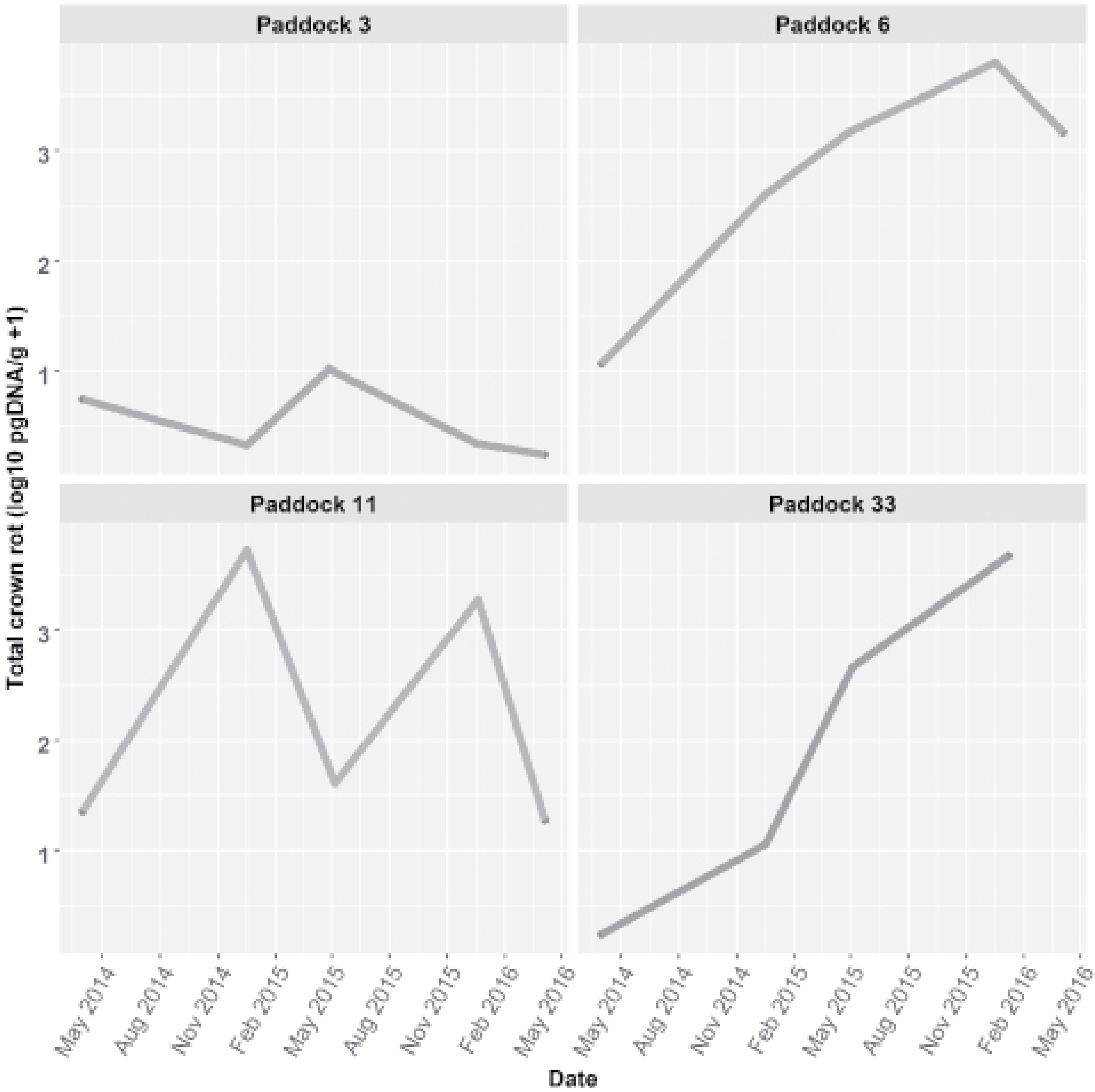

Figure 3. Crown rot inoculum changes over time of four individual paddocks during the growing season. Measurements taken pre-sowing and postharvest from 2014 to 2016. Total crown rot is the combined inoculum of *Fusarium pseudograminearum* and *Fusarium culmorum*. Log risk levels: below detection = <0.6, low = 0.6–<2.0, medium = 2.0–<2.5 and high = ≥2.5 for bread wheats in sNSW.

Crop protection

Implications for growers

All paddocks will build up crown rot inoculum at different rates depending on the management practices. The climatic conditions of 2014 and 2015 were conducive to developing high levels of crown rot across southern NSW. Cool, wet winters followed by a relatively dry spring allowed low levels of crown rot to increase to medium–high levels in some paddocks. Many of the survey paddocks observed with high levels of crown rot also have other diseases present such as take-all, creating disease complexes that can exacerbate yield losses.

Cereals increased the pre-sowing levels of crown rot when compared with canola and other non-host species as the previous crop. However, canola does not always lower inoculum levels and these situations require further investigation.

The current recommendation to growers in the presence of high levels of crown rot is to remove cereals from the paddock's rotation. Sow a pulse or oil seed crop to allow the inoculum to break down and, if possible, do so for more than one season. If a cereal must be grown, consider sowing barley. Due to the earlier maturity of barley and its higher tolerance, this can potentially negate the effects of crown rot during the grain-fill stage. However, it must be noted that barley is a susceptible crop to crown rot and it will not reduce the inoculum build up during the growing season.

References

McKay A, Mayfield A & Rowe S, eds, 2015. *Broadacre soilborne disease manual: PreDictaB™ DNA soilborne disease DNA tests.* South Australian Research and Development Institute.

Acknowledgements

Thank you to the growers who allow access to their paddocks for the survey data to be collected and the agronomist who facilitated the access.

All technical components of conducting these experiments were carried out by Tony Goldthorpe, Brad Baxter (NSW DPI), Chris Minehan (Rural Management Strategies), James Whitley (previously Riverina Co-op), Tim Tarlington (Riverina Co-op) and Will Haines (Landmark).

The southern NSW paddock survey has been conducted under the 'National crown rot management program – Southern NSW component', DAN00175, 2014–18 with joint investment by GRDC and NSW DPI.