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Controlling septoria tritici blotch through crop management (CoSTM)

Key external stakeholders:

Tillage farmers, Tillage Advisors (Teagasc & Independent), Agrichemical industry, Regulators, Researchers

Practical implications for stakeholders:

Whilst scope exists through crop management practises to reduce septoria tritici blotch (STB) pressure, these alone will not be sufficient to control the disease. Future control should follow the principals of integrated pest management, exploiting all available means of control. These include:

- Utilising varietal resistances and fungicides in a manner that maximises the efficacy of both and is reflective of local disease pressures.
- Delaying sowing in autumn as late as is feasibly possible without adversely impacting yield to reduce infections levels prior to winter.
- Tailoring nitrogen fertilisation to match yield potential

Main results:

Analysis of the efficacy of fungicides and varietal resistance over the past 15 years demonstrates that the Irish *Z. tritici* population readily responds to overcome the pressures imposed by disease control programmes. Whilst the overall levels of varietal STB resistance have improved during this time period, based on current levels of resistance available in commercially grown varieties little scope exists to reduce current fungicide inputs without adversely impacting yield. However additional measures can aid disease control. Delaying sowing has an impact on disease development and subsequently how the crop can be treated, however this is location and season specific. Altering seeding rates had no impact on disease development irrespective of varietal resistance. Altering N fertilisation rates influenced levels of STB, with greater impacts observed in the more susceptible varieties. However these differences were only observed between the extreme rates of N fertilisation, with significant yield losses observed at the lower rates which also exhibited the lower levels of STB. Both sulphur and boron provided significant levels of disease control and yield protection when compared to the untreated control. However this was significantly lower than that provided by the conventional fungicide Adexar. When included as part of a fungicide programme both micronutrients added to disease control, however in the case of sulphur differences in the sensitivity of the Irish *Z. tritici* population was observed and selection for those strains less sensitive to the micronutrient is likely to occur if it is widely used.

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Opportunity / Benefit:

Both the fungicide and varietal dataset established represent a valuable resource, which can be used into the future to explore how STB is impacting Irish winter wheat production. Equally, the airborne collection is being further utilised to determine the frequency of specific mutations associated with fungicide resistance across a range of economically important cereal pathogens.

Collaborating Institutions:

University College Dublin (UCD); AHDB; ADAS; SRUC; NIAB

Teagasc project team:
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External collaborators:
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1. Project background:

Septoria tritici blotch (STB) caused by the fungal pathogen *Zymoseptoria tritici* is the most economically destructive disease of winter wheat in Ireland. Current control is heavily reliant on the timely application of fungicides. The development of resistance to the main fungicides used for STB control and increasing restrictions on their usage increases the need to provide alternative solutions. To ensure the applicability and sustainability of such control programmes they must align to the principals of integrated pest management, with emphasis being placed on the initial prevention and suppression of the disease. As agronomic practices employed throughout the different stages of winter wheat production can influence disease development, scope may exist to alter these practices to aid the control of STB. The aim of CoSTM was to identify these practices and to evaluate if the potential exists under Irish growing conditions for them to be altered in a manner that reduces disease pressures without adversely impacting upon yields.

2. Questions addressed by the project:

- Can early season agronomic practices including varietal resistance and sowing dates be used to tailor fungicide control programmes?
- Do agronomic practices that influence the crop mid-season (seeding rate and N fertilization) impact on STB development
- Can micronutrients be used to aid the control of STB, and if so what impacts may they have on the wheat phylloplane microbiome?

3. The experimental studies:

The project consisted of a revaluation of trial data available at Teagasc, five seasons of field trials conducted by both Teagasc at the Crops Research Centre, Oak Park and by UCD at the Lyons Research Farm, airborne sampling for *Z. tritici* detection, and establishing the potential for micronutrients to supress STB development.

An initial evaluation of how STB control has changed over the past 15 years was conducted by analysing existing Teagasc STB fungicide control datasets. To assess how varietal resistances have changed during the same period levels of resistance relative to seed availability and resistance of each variety was calculated. Seed availability was determined from quantities submitted to DAFM as part of the seed certification scheme, whilst resistance ratings were extracted from the recommended list trials conducted each season by DAFM.

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In line with the principals of IPM, varietal resistance formed a key factor across all field trials. Using a range of varietal resistances a suite of trials investigated a) the capacity to adjust components of the fungicide programme to reflect increasing varietal resistance (trials undertaken in conjunction with the CIVYL project - 6422) b) whether fungicide programmes can be altered to reflect the date of sowing, with airborne spore sampling conducted at five locations to ensure the applicability of the trial findings across a wider range of environments c) whether seeding rates at which the crop is established influenced the epidemic development and d) whether increases in N fertilisation increased STB levels.

To determine the potential of micronutrients to supress STB development, field trials were conducted with eight micronutrients applied at growth stage 39. Sensitivity based assessments on 380 isolates were conducted to determine the range in sensitivity amongst the Irish *Z. tritici* population to the micronutrients boron and sulphur. Furthermore the impacts these micronutrients have on the wider wheat phylloplane microbiome was investigated in the presence / absence of a conventional fungicide programme at three locations in 2018.

4. Main results:

Over the 15 seasons of collated trials data where STB was allowed to develop, a mean loss of 2.2 t/ha was recorded, demonstrating the importance of controlling the disease under Irish growing conditions (Figure 1). During the same period, whilst varieties with increased resistance to the disease became commercially available, the average resistance of varieties grown in Ireland only increased by 0.9, from a rating of 4.3 to 5.2 on a scale of 1-9. Unfortunately, such increases in resistance are inadequate to allow for reductions in rates of currently applied fungicides. This was further confirmed with the capacity to lower the dose of the multisite component of fungicide programmes only possible on those varieties with extremely high levels of resistance (resistance rating >7). These findings are in agreement with those previously identified for site-specific fungicides conducted as part of the CIVYL project.

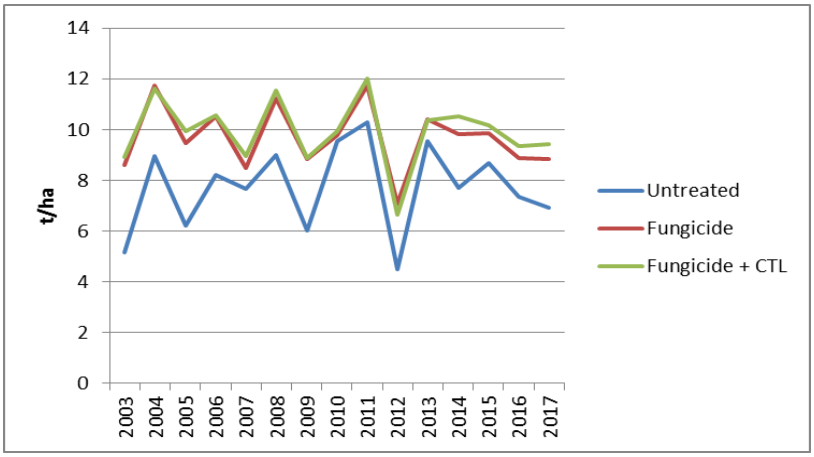

Figure 1. Impact of septoria tritici blotch and fungicides on Irish winter wheat yields 2003-2017.

A total of eight sowing date trials were conducted as part of the project, with these trials also aligned with a similar project being conducted in the U.K. as part of a jointly funded AHDB/BASF trials series allowing a diversity of STB pressures to be captured. Collectively significant effects on yield of site, variety and fungicide were observed in line with what would be expected in such a trial series. Further analysis of this trial series is still ongoing. A large collection of airborne samples has been established and DNA extracted and catalogued. Analysis of these samples for the critical period of mid-late autumn confirms the presence of airborne inoculum, with similar quantities detected elsewhere in Europe.

Seeding rates from 100-500 seeds / m^2 (and respective interactions with varietal resistance) had no impact on recorded STB levels. Conversely, a significant effect of N fertilisation on STB disease levels was detected, with lower levels of STB associated with the lower rates of N, with impacts greater on the more susceptible varieties. The differences observed were mostly between those N rates at the extreme ends of the range investigated, with limited differences observed between those most relevant to maximising yields under Irish production systems.

Of the eight micronutrients applied only boron and sulphur provided significant control of STB and yield protection compared to the untreated. These were however significantly lower than those provided by the azole/SDHI fungicide Adexar also included in the trial. To further investigate the applicability of both boron

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and sulphur for STB control three field trials were conducted in 2018 where each were either applied alone or as replacements for the multisite chlorothalonil as part of a conventional fungicide programme. In all three trials, no significant differences were observed in disease or yield when either micronutrient were included in the fungicide programme. When applied alone levels of disease control and yield were significantly lower.

The potential impacts both sulphur and boron may have on the wider winter wheat phylloplane were investigated following amplification and sequencing of both the 16s and ITS regions leaf samples taken from these trials. Trial location had the biggest impact on the diversity of the phylloplane microbiome, even where the trials were conducted on the same winter wheat variety. The sensitivity of representative Irish collections of *Z. tritici* to both boron and sulphur were determined using agar plate assays. Differences in sensitivity were observed amongst the collections to sulphur, highlighting that selection for these strains may occur if increased usage of foliar applications of sulphur are used as a means of its control.

5. Opportunity/Benefit:

Both the fungicide and varietal dataset established represent a valuable resource, which can be used into the future to further determine how STB is impacting Irish winter wheat production. Equally, the airborne collection represents a valuable resource and is being further utilised to determine the frequency of specific mutations associated with fungicide resistance across a range of economically important cereal pathogens. Whilst the yield penalties incurred through lower N fertilisation limit current reduction in usage, confirmation that reduced N input reduced STB severity highlight that further research on N optimisation are required. Although both sulphur and boron only provided moderate levels of STB, in the absence of chlorothalonil these may provide the disease control previously provided by a multisite fungicide. Further research is warranted to determine if they too provide the anti-resistance provided by chlorothalonil. Across all the trials the benefits of varietal resistance were identified for STB control. Under Irish conditions this resistance needs to be high (resistance rating >7) if it is to provide the consistent levels of disease control required.

6. Dissemination: Selection of key events/publications

Knowledge Transfer events:

- Septoria Conference 22nd March 2017: Preserving current and future control
- Septoria Crop Walks: Carlow (17th June 2014), Meath (19th June 2014), Cork (20th June 2014)
- Septoria Crop Walks: Meath (3rd July 2017), Cork (5th July 2017), Laois/Carlow (7th July 2017)
- Tillage Crops Open Day, Oak Park Carlow: 24th June 2015; 28th June 2017; 27th June 2019
- National Tillage Conference Poster Presentations 2017 – 2019.

Conference Papers:

Dooley H, Spink J, Kildea S (2016) Controlling septoria using management practises. Proceedings of Crop Protection Northern Britain 2016 p169-174

McCabe (2017) Is cultural control really applicable for septoria? *Septoria Conference: Preserving current and future control 22nd March 2017*

Dooley H, Kildea S (2018) Can applications of foliar micronutrients help to manage septoria tritici blotch, causal agent *Zymoseptoria tritici*? *Irish Fungal Society Annual Meeting June 18th 2018*

Rathore DS, Dooley H, Kildea S (2018) Investigating the impact of fungicides and micronutrients on septoria tritici blotch (STB) and associated wheat phylloplane microbiome. *Microbiomes Underpinning Agriculture 1-2 October 2018*

Rathore DS, Dooley H, Rathore R, Byrne S, Doyle D, Cotter PD, Kildea S (2019) Studying the impact of fungicides and micronutrients on septoria tritici blotch of wheat and its associated phylloplane microbiome. *Irish Plant Scientists Annual Meeting June 25-27 June 2019*

Rathore DS (2020) Studying the effect of foliar application of fungicide and micronutrients on septoria tritici blotch and microbial diversity of wheat. *Eduard Strasburger Workshop on Plant Microbe Interactions 3-5 February 2020*

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