



An Roinn Talmhaíochta,  
Bia agus Mara  
Department of Agriculture,  
Food and the Marine

# 13S503 - Controlling septoria tritici blotch through crop management

## Final Report

This project was funded under the Department of Agriculture,  
Food and the Marine Competitive Funding Programme.

## **SUMMARY**

Controlling Septoria tritici blotch Through Crop Agronomy (CoSTM) aimed to establish if manipulations of current cropping practises can be used to aid control of septoria tritici blotch (STB) of winter wheat in Ireland. To achieve this the project collated and reviewed trial data spanning the past 15 years, established a series of trials investigating the potential of varietal resistance, sowing date, seeding rate, N fertilisation and micronutrients to control STB. Analysis of the efficacy of fungicides and varietal resistance over the past 15 years demonstrates that the Irish Zymoseptoria 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 and further investigations are required to demonstrate how these can be fully utilised in controlling STB to acceptable levels.

## **KEYWORDS**

Wheat, Agronomy, disease control

### **ACRONYM**

CoSTM

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### **PUBLICATION DATE**

October 2020

# Section 1

## Start Date

01 March 2014

## End Date

30 September 2019

## Select Research Programme

Research Stimulus Fund

## Please select the appropriate TRL Scale

TRL 6: Technology demonstrated in relevant environment

## NRPE Priority area

Sustainable Food Production and Processing

## Total DAFM Award

€610,916.89

## Total Project Expenditure

€378,187.88

## Keywords

Wheat, Agronomy, disease control

## Overall Project Summary

Controlling Septoria tritici blotch Through Crop Agronomy (CoSTM) aimed to establish if manipulations of current cropping practises can be used to aid control of septoria tritici blotch (STB) of winter wheat in Ireland. To achieve this the project collated and reviewed trial data spanning the past 15 years, established a series of trials investigating the potential of varietal resistance, sowing date, seeding rate, N fertilisation and micronutrients to control STB. Analysis of the efficacy of fungicides and varietal resistance over the past 15 years demonstrates that the Irish Zymoseptoria 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 and further investigations are required to demonstrate how these can be fully utilised in controlling STB to acceptable levels.

## Rationale for undertaking the Research

Septoria tritici blotch (STB) caused the fungal pathogen Zymoseptoria tritici continues to be the most economically destructive disease of winter wheat in Ireland. For almost three decades fungicides have been relied upon for its control and to prevent associated yield losses. Unfortunately due to the erosion in efficacy of these fungicides through the emergence of resistance / reduced sensitivity in the Irish Z. tritici population, coupled with increased regulations on the usage fungicides in the EU the future sustainability and profitability of Irish winter wheat production systems is questioned. It is therefore now essential to re-address STB control strategies. Such control must incorporate additional control measures in a manner that fits with the principal of integrated pest management (IPM). These must have their foundations based on the initial prevention and/or suppression of the disease. For them to be successful they must be tested under Irish growing conditions. To further develop these strategies their success or failure must be further investigated. CoSTM aims to identify and evaluate the most appropriate measures applicable to Irish production systems.

## Methodology

To address the objectives set out in CoSTM five experimental tasks were established.

### 1. Analysis of historical data relating to STB disease control

Historical Teagasc field trial data (variety, fungicide and agronomy) data was assessed in specific relation to impacts on STB levels. In addition in collaboration with DAFM data on the availability of winter wheat seed for the period 1997-2017 was analysed in relation to changes in resistance/susceptibility of each variety during this period.

## 2. Establishing optimum fungicide dose for winter wheat varieties varying in resistance

In collaboration with the CIVYL project the potential of increasing resistance in winter wheat to reduce fungicide inputs were further evaluated.

## 3. Assessing impact of early season agronomic practises on STB epidemics

In collaboration with a AHDB/BASF funded project in the U.K. the impacts of sowing date in conjunction with varietal resistance was investigated in field trials conducted across multiple locations in Ireland and the U.K. The presence of airborne ascospores of *Z. tritici* was determined by establishing a spore trapping network.

## 4. Potential for mid-season agronomic practises to reduce STB epidemics

Field trials were established to determine the impacts of both increasing nitrogen application or seeding rates on the development of STB in the latter stages of the season. These trials were conducted across a number of winter wheat varieties differing in resistance to STB.

## 5. Dissecting the interactions between nutrients and STB

Field trials were established to evaluate the ability of foliar applied micronutrients to control STB. The ability of Sulphur and Boron to control STB was further evaluated as part of commercial fungicide programmes. Using these trials the impact of fungicides in combination with either micronutrient on the wheat phyllosphere was investigated by next generation sequencing of the fungal and bacterial species present in the wheat leaves post treatment.

## Project Results

### Historical data relating to STB disease control

Analysis of the historical trials data (2003-2017) available at Teagasc confirmed the impacts STB can have on winter wheat yields, with mean loss of 2.2 t/ha where STB was left unchecked. Over the past two decades although increases in varietal resistance have been made (mean resistance value of wheat sown in 2017 was 5.2 compared to 4.4 in 1998). It is however questionable if these changes in resistance are sufficient to allow changes in fungicide regimes given the potential yields losses that may occur.

### Establishing optimum fungicide dose for winter wheat varieties varying in resistance

The difficulties facing growers in utilising varietal resistance to reduce fungicide input was demonstrated in the variety x fungicide dose response trials. In collaboration with the CIVYL project additional varieties (JB Diego & Einstein) were evaluated in addition to the protective only treatment chlorothalonil. As per the CIVYL findings significant reductions in fungicide input, including for the protectant only treatment, could only be achieved on the highly resistant variety without adversely impacting yield and economic return.

### Assessing impact of early season agronomic practises on STB epidemics

A total of 8 field trials were conducted (18 trials across Ireland and the U.K. in collaboration with the AHDB/BASF funded project) investigating the impacts of delayed sowing and various interactions on STB control and subsequent yield. Large site effects were observed on the disease data, reflective of the large geographic spread of the trials. No interactions between sowing date and fungicide treatment on yield were observed. Spore traps were established at five locations representing the main wheat producing regions of Ireland and *Z. tritici* was detected throughout the autumn and winter months at equal levels suggesting that sufficient inoculum will exist to initiate epidemics irrespective of how late winter crops are sown.

### Potential for mid-season agronomic practises to reduce STB epidemics

A total of 11 field trials (7 seeding rate trials and 4 N fertilisation trials) were conducted. Whilst varietal resistance significantly impacted levels of STB, that increased or reduced seeding rates or their interaction with varietal resistance did not affect disease levels indicating that the manipulation of seeding rates within the range that doesn't impact yield has limited potential to reduce STB pressure. Increased N fertilisation increased levels of STB. This was varietal dependent, with greater increases observed on the more susceptible varieties. Unfortunately the significant differences observed were only between those at the extremes of N fertilisation.

### Dissecting the interactions between nutrients and STB

Both Boron and sulphur significantly reduced levels of STB and retained yields compared to the untreated control. This was further demonstrated when both nutrients were incorporated into fungicide control programme in place of a multisite fungicide in trials in 2018 and again in 2019 (only sulphur was investigated). Trial location had the greatest impact on the wheat phyllosphere as determined by the abundance of different fungi and bacteria species in the wheat leaves post treatment. Differences in sensitivity to sulphur were observed in vitro.

## Section 2 - Research Outputs

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### Summary of Benefits / Improvements of Project Findings

The findings of CoSTM further highlight the difficulties Irish wheat growers will continue to face in their challenge to control STB. The extensive review of Teagasc trials and the changing dynamics of winter wheat varieties grown in Ireland are reflective of this, with only minor improvements in STB varietal resistances being grown and consistent yield losses of >2 t/ha over the same period in trials where the disease was left unchecked. Irrespective of the fungicide chemistry applied, significant reductions in application are only possible on those varieties exhibiting high levels of STB resistance. Unfortunately very few varieties with these levels of resistance exist, and of those that are available they are not favoured by growers as evident by the proportion of seed availability between 1997-2017. Evidence was provided that delaying sowing to mid-late autumn doesn't drastically impact yield. In addition to potential reductions in disease delayed sowing can be expected to help reduce weed and insect pressure. However it should be noted that disease pressures were not always reduced and location specific pressures etc must be taken into account. Unfortunately the differences in STB levels observed in the N fertilisation trials conducted in

CoSTM were only between the extreme N application rates, with lowest STB observed on the unfertilised plots. If changes in practice can be achieved whereby reductions in N fertilisation can be lowered without adversely impacting yield then the potential to reduce STB pressure exists. Both sulphur and boron provided moderate levels of STB control when applied as foliar applications. Following the loss of chlorothalonil the potential exists for such micronutrients to become a part of fungicide programmes. Further analysis of their potential is warranted, however as differences in sensitivity were observed in vitro their application and impacts on local *Z. tritici* populations must be monitored.

### Summary of Staff Outputs

Research Output	Male	Female	Total Number
Post Doctorates	0	1	1
Research Technicians/ Assistants	1	1	2

### Summary of Academic Outputs

Research Outputs	Total Number	Details
Publications in Peer Reviewed Scientific Journals	1	Lynch JP, Glynn E, Kildea S & Spink J (2017) Yield and optimum fungicide doses rates for winter wheat ( <i>Triticum aestivum</i> L.) varieties with contrasting ratings for resistance to septoria tritici blotch. <i>Field Crops Research</i> 204: 89-100  Participation of S Kildea was through CoSTM project
Peer Reviewed Conference Papers	2	Dooley H, Spink J, Kildea S (2016) Controlling septoria using management practises. <i>Proceedings of Crop Protection Northern Britain 2016</i> p169-174  Kildea S, Dooley H, Phelan S, Mehenni-Ciz & Spink J (2016) Developing fungicide control programmes for septoria tritici blotch in Irish winter wheat crops. <i>Proceedings of the 18th International Rheinhardtsbrunn Symposium</i> , p171-174
Other	1	Teagasc Report: An evaluation of the potential impact the loss of chlorothalonil may have on the productivity of winter wheat and spring and winter barley grown in Ireland  <a href="https://www.teagasc.ie/media/website/publications/2018/Potential-Impactsloss-of-chlorothalonil-may-have-on-cereal-production.pdf">https://www.teagasc.ie/media/website/publications/2018/Potential-Impactsloss-of-chlorothalonil-may-have-on-cereal-production.pdf</a>

### Intellectual Property

*No Response*

## Summary of other Project Outputs

Project Outputs	Details	Total No.
New Industry Collaborations Developed	Collaboration between the CoSTM project and the AHDB/BASF funded project in the U.K. Research partners include ADAS, NIAB, SRUC, BASF and AHDB. This specifically related to the sowing date trial (Task 3).	1

## Potential Impact related to Policy, Practice and Other Impacts

Impact	Details
Environmental Sustainability	<p>CoSTM clearly identified the issues facing winter wheat growers in their challenge to control STB. Whilst the need to integrate disease control strategies for the control of STB is widely accepted by dissecting and investigating each individual component does it become apparent how difficult this will be. - Currently without the availability of fungicides significant yield losses can be expected</p> <ol style="list-style-type: none"> <li>1. Varieties with high levels of durable resistance that are favorable to growers will be required if significant reductions in fungicide usage is to be reliably achieved</li> <li>2. Delaying sowing until late autumn doesn't drastically reduce yields, however its benefits for disease suppression are not clear</li> <li>3. If significant reductions in N application can be achieved without adversely impacting yields there will be added</li> <li>4. Limited scope exists for the inclusion of micronutrients (sulphur and boron) in disease control programmes. However, levels of disease control achieved are not comparable to current fungicides.</li> </ol>
Socio-Economic	<p>CoSTM identifies clearly the impact STB can have on winter wheat yields. It equally identified the difficulties facing the industry in combating the disease and the need to ensure a variety of control measures is available. CoSTM demonstrates throughout each task how reliant current production systems are on fungicides and hence the overall vulnerability to Irish winter wheat production to potential changes in fungicides use whether due to the development of resistance in the Irish <i>Z. tritici</i> population or restrictions in usage due to changes in regulations. To reduce this significant improvement in varietal resistance will be required in combination with agronomic practices that help alleviate disease pressures.</p>
Industry	<p>CoSTM highlights the need for industry (wheat breeding companies, fungicide manufactures, agronomists) to work together to combat STB. As each experimental task demonstrated tackling the individual components separately fails to adequately provide significant reductions in STB without adversely impacting yields.</p>

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## Dissemination Activities

Activity	Details
Seminars at which results were presented	<p>Kildea (2015) Cereal disease control in 2015. Teagasc National Tillage Conference 2015</p> <p>Dooley H (2016) Controlling septoria through crop practises. 9th Symposium of septoria diseases of cereals. Paris 2016</p> <p>Kildea S (2016) An Irish perspective on controlling septoria. Association of Independent Crop Consultants Annual Conference 2016</p> <p>Kildea S (2016) Wheat disease control and resistance issues. National Tillage Conference 2016.</p> <p>McCabe (2017) Is cultural control really applicable for septoria? Septoria Conference: Preserving current and future control 22nd March 2017</p> <p>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</p> <p>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</p> <p>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</p>
Workshops at which results were presented	<p>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</p>

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## Knowledge Transfer Activities

### Identify knowledge outputs generated during this project.

Impact of STB on Irish wheat yield: The review of Teagasc trials 2003-2017 confirmed the impact of STB on Irish winter wheat yields, reinforcing the need to ensure sufficient disease control measures are taken. This was highlighted as part of the Teagasc report on potential impacts following loss of CTL.

Need for high levels of varietal resistance to combat STB: Through the variety x fungicide trials the need for high levels of varietal resistance was demonstrated if significant reductions in fungicide usage are to be achieved.

Role for delayed sowing in combating STB: Whilst the impact of delaying sowing of winter wheat crop until mid-late autumn on STB levels was not consistent, limited impact on yield was observed as long as sowing did not extend into mid-winter.

Role of micronutrients: Whilst further investigations into the potential role of sulphur and boron for STB suppression is warranted there was no evidence that the other micronutrients investigated (copper, magnesium, manganese, potassium, silicon and zinc) are able to suppress STB when applied as foliar applications.

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### Identify any knowledge transfer activities executed within the project.

SKildea: Septoria crop walk Carlow, Cork, Meath 17/06/2014, 19/06/2014, 20/06/2014

SKildea: European Extension Meeting Trials Tour presenting to Agronomists from UK, Denmark and Sweden 11/07/14

SKildea: Crops and Spraying'14 presenting project 03/07/14

SKildea: BASF Trials Tour demonstrating trials 18/06/14

SKildea: Crops Open Day 2015 presenting Trials 24.06.2015

S Kildea: BASF Trials Tour presenting trials 08.07.2015

S Kildea: European Extension Meeting 15.02.2017-17.02.2017

S Kildea: BASF trials Tour in Oak Park presenting trials 04.07.2016

S Kildea: Syngenta Trials Tours in Oak presenting trials 11.07.2016-15.07.2016

S Kildea: Teagasc trials Tour in Oak Park presenting trials 22.06.2016

T McCabe: Disease control in Oak Park Demonstrating trials to UCD undergraduate students 21.04.2016

S Kildea: Septoria Control Presentation to AICC in U.K. 10.11.2016

S Kildea: STB Agronomy meeting to provide up-date on Irish trials 01.11.2017

S Kildea: Crops Open Day 2017 presenting trials 29.06.2017

SKildea: Presenting data from agronomy trials to U.K. collaborators 22.03.2017

S Kildea: Septoria crop walks Carlow, Cork and Meath 03.07.2017 05.07.2017 07.07.2017

S Kildea: EURO-RES Trials Tour demonstrating CoSTM trials to researchers from Belgium, Denmark and Sweden 13.07.2017

S Kildea: European Experts Meeting Oslo attending and discussing CoSTM trials to European researchers 14.02.2018-16.02.2018

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**List any impacts resulting from the knowledge transferred during the project**

Integration of disease control measures in developing disease control programmes

This is evident by the increase commercial trialing of new fungicides across varieties differing in fungicide resistance and agronomy practices – as demonstrated in the industry collaboration represented in Task 3.

Optimization of disease control programmes

In addition to the integration of measures increased emphasis and knowledge on ensuring the correct timing and choice of fungicide amongst the entire industry (agronomists and growers). This is now evident through the various agronomy newsletters and advice being given directly to growers.

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## Section 3 - Leveraging, Future Strategies & Reference

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### Leveraging Metrics

Type of Funding Resource	Funding €	Summary
EU R&I programmes	€1,102,411.00	EURORES Project funded as part of C-IPM ERANET, Teagasc coordinating (2017-2020)
Exchequer National Funding	€153,000.00	Teagasc internal - monitoring crop pathogens (2016-2020)
Exchequer National Funding	€150,000.00	Teagasc internal - Future Disease Control (2018-2022)
Exchequer National Funding	€766,915.00	Establishing a platform for integrated pest management in Ireland (EPIC-IPM) (2015-2020)

### Future Strategies

It is expected that over the coming 12 months the findings from CoSTM will be written up in the form of peer-review publications. In addition the resources generated are being further exploited as outlined below. Collated datasets:

The combination of the extensive field trials conducted as part of CoSTM and the datasets collated of past trials is being used to evaluate the potential implications of the proposed reductions in pesticide usage may have on winter wheat production in Ireland.

#### Spore trapping:

The DNA extracted has been used to screen for mutations associated to resistance in *Z. tritici* as part of the EURO-RES project. In addition it is also being used by a Teagasc Walsh Scholar to detect *Pyrenopeziza brassicae* and associated fungicide resistance mutations.

#### Microbiome analysis:

As next generation become more accessible to researchers it is expected that the impacts of fungicides etc on the plant microbiome will be further investigated. The resources established including the raw materials, networks established with the Teagasc Moorepark researchers leading this research in the food and animal area and downstream analysis pipelines will ensure Teagasc is at the forefront of this research.

### Project Publications

Lynch JP, Glynn E, Kildea S & Spink J (2017) Yield and optimum fungicide doses rates for winter wheat (*Triticum aestivum* L.) varieties with contrasting ratings for resistance to septoria tritici blotch. *Field Crops Research* 204: 89-100 (Participation of S Kildea was through CoSTM project)

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

Kildea S, Dooley H, Phelan S, Mehenni-Ciz & Spink J (2016) Developing fungicide control programmes for septoria tritici blotch in Irish winter wheat crops. *Proceedings of the 18th International Rheinhardtsbrunn Symposium*, p171-174

Teagasc Report: An evaluation of the potential impact the loss of chlorothalonil may have on the productivity of winter wheat and spring and winter barley grown in Ireland (<https://www.teagasc.ie/media/website/publications/2018/Potential-Impacts-loss-of-chlorothalonil-mayhave-on-cereal-production.pdf>)