

**Project number:** 6422

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## Cereal Improvement through Variety choice and understanding Yield Improvements (CIVYL)



### Key external stakeholders:

Tillage farmers, Agronomists, plant breeders, variety testers

### Practical implications for stakeholders:

- Commercial yields of both spring barley and winter wheat are well below their potential.
- Current variation in agronomic characteristics of recommended varieties such as septoria resistance do not reliably indicate the likely response to inputs such as fungicides, and can therefore not be reliably used to alter the level of inputs.
- Varieties which combine higher levels of septoria resistance than currently commercially available and high yield potential can be produced.

### Main results:

Commercial yields of both spring barley and winter wheat are well below their potential.

Current variation in agronomic characteristics of recommended varieties such as septoria resistance do not reliably indicate the likely response to inputs such as fungicides, and can therefore not be reliably used to alter the level of inputs.

### Opportunity / Benefit:

A detailed description of the growth and yield formation of both spring barley and winter wheat are given in guides available in hard copy and on the Teagasc web site. These guides also collate the latest agronomic advice for the 2 crops and can be used to optimize production.

Research investigating septoria resistance has indicated previously unidentified mechanisms which can be used by breeders to develop more resistant varieties.

### Collaborating Institutions:

Teagasc, UCD and AFBI

### Teagasc project team:

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### External collaborators:

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### 1. Project background:

The structure of the farming industry and climate gives Ireland a high cost of production of cereals, exploitation of the high yield potential to minimise the cost/t is critical to remain competitive. A detailed knowledge of crop growth and development in any given environment is the first step to understanding yield formation and how yield is being restricted.

Winter wheat and spring barley are the 2 most important tillage crops in Ireland, yet there has been no domestic breeding of varieties of either for some decades. Tillage farmers are reliant on the import and testing of varieties from overseas breeding programmes primarily the UK but also other north western European countries. The primary test for a variety's suitability is yield and a variety can be added to the recommended list after 3 years of testing. Climatic conditions in Ireland differ considerably from the East of England and Europe where the breeding programmes are based, thus the relative importance of agronomic characteristics differs significantly from the areas where initial selections are based. A knowledge of the economic importance of varietal characteristics could be utilised to select varieties or lines earlier in the breeding cycle that are likely to be well suited to Ireland.

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### 2. Questions addressed by the project:

How is growth development and yield formation in winter wheat and spring barley affected by variation in the weather in Ireland and how does this limit yield?

What are the characteristics of wheat and barley varieties that have performed well in testing systems and commercial production?

To facilitate the development of Irish-specific varieties with an increased capacity to accommodate extended Septoria Tritici Blotch (STB) disease latent periods and as such have the potential to stall disease epidemics in the field and.

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### 3. The experimental studies:

In order to understand yield formation of winter wheat in Irish conditions reference crops of winter wheat sown from Cork to Northern Ireland were subjected to detailed developmental and physiological assessment. This provided a data set (along with a similar data set for spring barley from previous Teagasc funded research) which was used to model crop growth, development and yield formation.

Data sets of varietal performance from both public and private partners were collated and combined with DUS morphological data to identify characteristics associated with good performance in Ireland. Varieties with a range of a particular characteristic e.g. disease resistance or lodging resistance were then grown with a range of fungicide or plant growth regulator inputs to assess whether the economic optimum input level could be reliably predicted to alter with the resistance level of the variety.

A range of wheat varieties were screened for the consistency of their latent period to septoria across high (Waterford), medium (Carlow) and low (Norwich, UK) pressure sites. Molecular analysis of varieties contrasting in latent period was then used to attempt to identify potential new mechanisms and genes for septoria resistance.

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### 4. Main results:

The investigation into the growth and development of winter wheat in Ireland has been completed and results have been disseminated at national conferences, a farmers growth guide produced and a manuscript has been published in a peer review journal. Based on the findings, yield potential estimation models have been developed for winter wheat and spring barley, which take account of daily fluctuations in weather during a season and the potential impact of sowing date. Estimations of yield potential of both crops have been made for contrasting sites in Ireland, and maps have been produced that allow for the presentation of the results spatially.

A database comprising 12 component databases, six each for winter wheat and spring barley for AFBI (N Ireland), DAFM (Ireland), AHDB (formerly HGCA) (GB), Germinal (Ireland), Goldcrop (Ireland) and Seed Tech (Ireland) has been brought together. A total of 1729 trials are included with over 784,000 data points. This has been interrogated using various statistical approaches leading, finally, to the use of the yield penalty, the difference between treated, i.e. with fungicide and plant growth regulators, and untreated yields, i.e. without fungicide and plant growth regulators, as the character for determining the benefits of individual disease and agronomic characters.

Field trials in which the impact of varietal characteristics, including hectolitre weight and resistance to a range

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of foliar and stem diseases, on the relationship between crop inputs and the performance of the crop in terms of development, yield and economics, were carried out (over ? seasons and ? sites).

Results indicated that the current range of varieties available do provide advantages in reducing the risks of these negative factors, but do not allow for confident alterations in crop inputs to maximise efficiency.

Field trial investigations into how Septoria develops on wheat varieties with contrasting latent periods have been completed and a valuable dataset developed that describes the process in contrasting environments, with an associated article published in a peer-review journal. Furthermore, genetic differences between varieties that confer high and low Septoria resistance have been identified, with ..... This information will be valuable to breeders in the development of varieties that have increased resistance to Septoria tritici blotch disease, which will have a greater suitability for use in Ireland.

A new network has been established named the "Irish Cereals Improvement Network", which has members from all the important sectors of the tillage industry including farmers, breeders, seed merchants, agro-chemical merchants/developers, researchers, advisors and government personnel. The network has successfully met four times to date and allowed for a rapid dissemination of findings from the project to the industry. At the last meeting, the members voted to carry on these network meetings beyond the current project, indicating that the network has become a valuable resource to its members.

#### 5. Opportunity/Benefit:

This project has identified the gap between achieved yield and potential yield for spring barley and winter wheat in Ireland in addition to identifying the key yield limiting stages of the crops life cycle. This information can be used to identify future agronomic research needs, target crop inputs and direct future crop improvement activities.

The work on septoria resistance has significantly improved our understanding of resistance and brought forward the development in the future of more resistant and resilient wheat varieties.

#### 6. Dissemination:

##### Main publications:

JOSEPH P. LYNCH DEIRDRE DOYLE SHAUNA MCAULEY FIONA MCHARDY QUENTIN DANNEELS LISA C. BLACK ETHEL M. WHITE & JOHN SPINK (2017) The impact of variation in grain number and individual grain weight on winter wheat yield in the high yield potential environment of Ireland. European Journal of Agronomy 87, 40-49.

LYNCH, JP; GLYNN, E; KILDEA, S AND SPINK, J (2017) Yield and optimum fungicide dose rates for winter wheat (*Triticum aestivum* L.) varieties with contrasting ratings for resistance to septoria tritici blotch. FIELD CROPS RESEARCH. 204, 89-100.

J.P. LYNCH, R. FEALY, D. DOYLE, L. BLACK & J. SPINK (2017) Assessment of water-limited winter wheat yield potential at spatially contrasting sites in Ireland using a simple growth and development model. Irish Journal of Agriculture and Food Research DOI: <https://doi.org/10.1515/ijafr-2017-0007>

JAMES GERARD HEHIR, CLIONA CONNOLLY, AOIFE O'DRISCOLL, JOSEPH P. LYNCH, JOHN SPINK, JAMES K.M. BROWN, FIONA DOOHAN AND EWEN MULLINS. (2017) Temporal and spatial field evaluations highlight the importance of the pre-symptomatic phase in supporting strong partial resistance in *Triticum aestivum* against *Zymoseptoria tritici*. Plant pathology, DOI: 10.1111/ppa.12780

##### Popular publications:

SPINK, J., HENNESSY, M., LYNCH, J., O'DONOVAN, T., FORRISTAL, D., HACKETT, R., KILDEA, S., GLYNN, L., HICKEY, K., KENNEDY, S., PLUNKETT, M., WALL, D., & BRYAN, T. (2015), The Spring barley guide, Teagasc

LYNCH, J., SPINK, J., DOYLE, D., HACKETT, R., PHELAN, S., FORRISTAL, D., KILDEA, S., GLYNN, L., PLUNKETT, M., WALL, D., HUTTON, F., HENNESSY, M. & WHITE, E. (2016) The winter wheat guide, Teagasc.

#### 7. Compiled by: John Spink