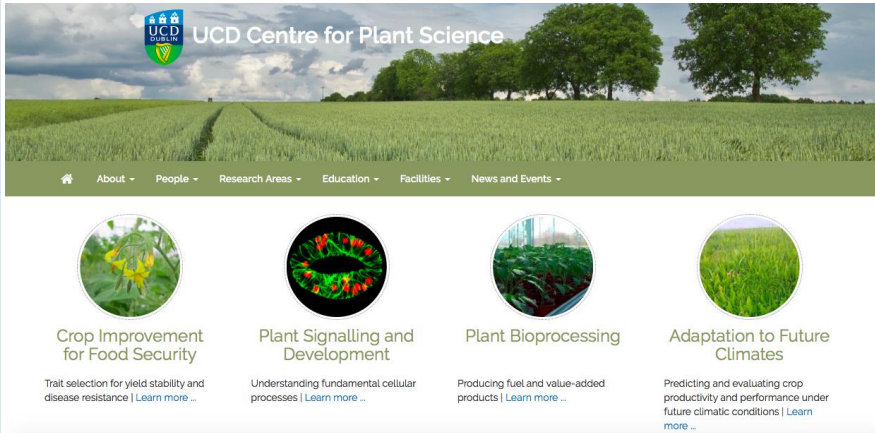


UCD Crop Science

UCD Centre for Plant Science



www.ucdplantscience.com

Physical resources

UCD SCIENCE CENTRE
biotech, data science



**Environmental station,
Climate change, propagation,
GM containment**



LYONS FARM



Our research areas:

- **Cereals (oats, wheat and barley), and more recently legumes**
 - **Disease control**
 - Mycotoxin control
 - Disease resistance
 - Biological disease control
 - **Reduced inputs agriculture**
 - Varieties
 - Biostimulants
 - **Nutrition**
 - Varieties, inputs, management



Soil health
Variety
Agronomy (management,
inputs)

Processing characteristics,
Nutrition/antinutritionals
Storage, shelf life

Health & wellbeing



**SUPERIOR
NUTRITION/REDUCED
ANTINUTRITIONALS**



**ADDED HEALTH
BENEFITS/TARGETED
GROUP**

Economic, environmental, social sustainability
Provenance (track and trace)

Today....



- **FHB work**
- **Oat work**
- **Results to date in OatFrontiers - Donegal**



TRICHOOTHECENES

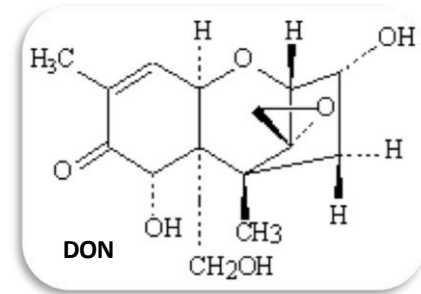


Produced by Fusarium fungi

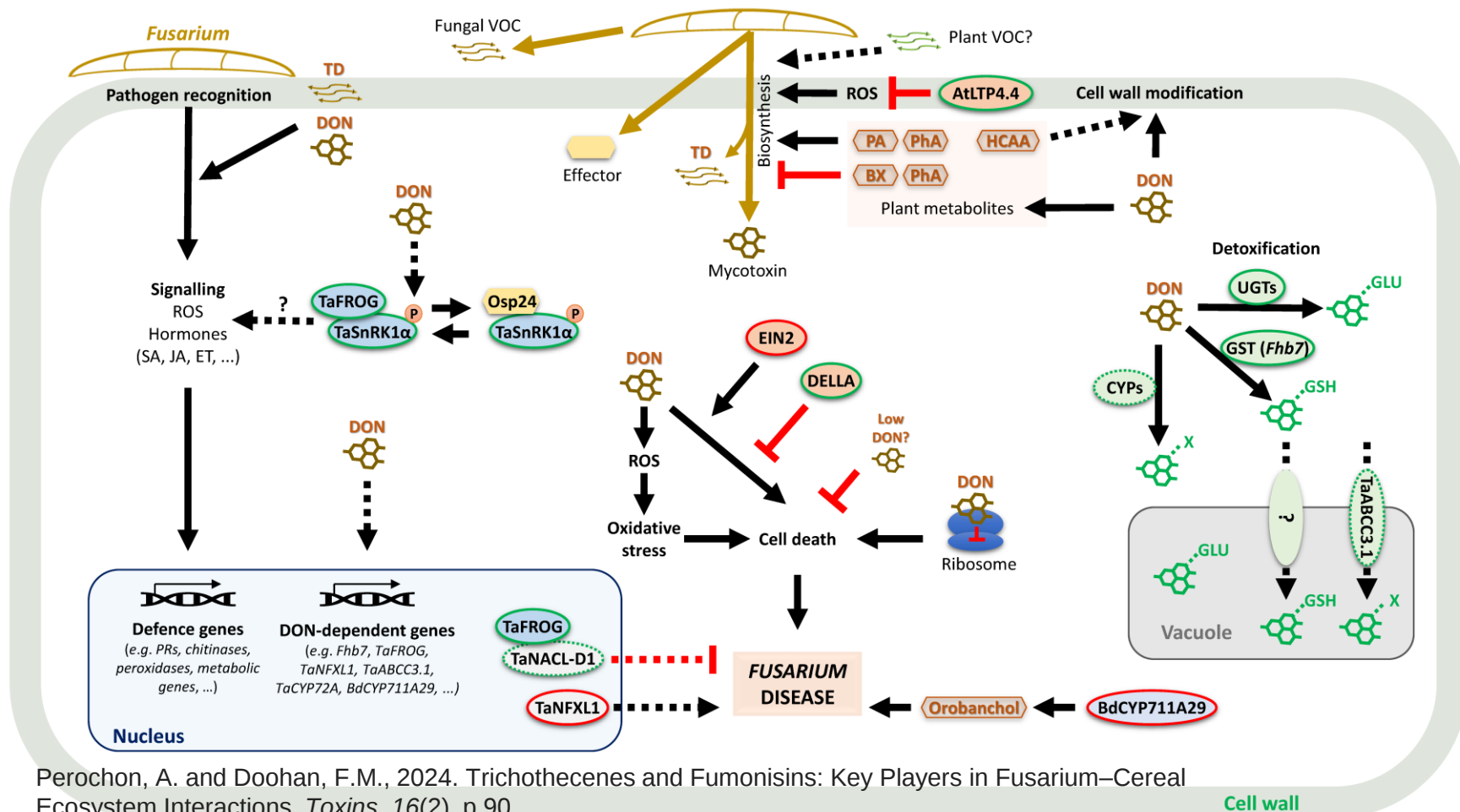
- *Very common on cereals and grass (heads and straw) - silage*
- *May be a bigger risk with maize silage than grass silage*

Types

- *Large family of toxins (>160)*
- *Most commonly found:
Deoxynivalenol (DON), T-2 toxin,
HT-2 toxin*



The many impacts of DON during FHB disease development



Our FHB work

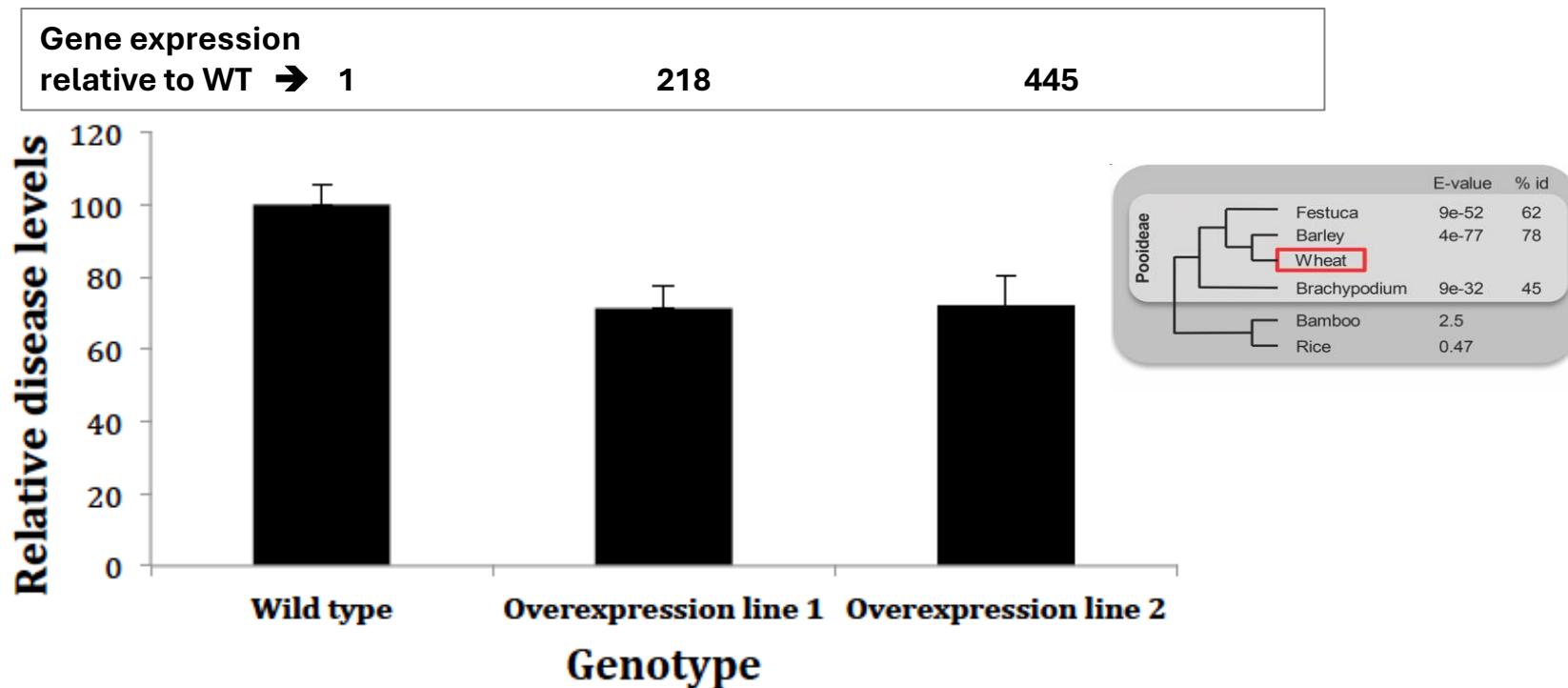
- Wheat and barley
 - Enhancing resistance to FHB/DON
 - Deciphering the mechanisms of FHB resistance –genes
 - Biocontrol
 - Breeding for healthy microbiomes
 - E.g. WheatSecurity – FACCE/JPI funded 2023-2026
 - WheatHealth- SFI funded 2024-2028

 SusCrop – ERA-NET Cofund on Sustainable Crop Production FACCE/JPI	
WheatSecurity Stakeholder Meeting 2023	
15 th September 2023 Online event	
Agenda	
10:00 – 10:05	Opening – Welcome
10:05 – 10:15	WheatSecurity Project – Introduction <i>Prof Fiona Doohan</i> – University College Dublin
10:15 – 10:30	Interrogation of existing data and resources <i>Dr Sophie Bouchet</i> – GDEC INRAE
10:30 – 10:45	Genetic basis of yield stability: adaptation, resource use efficiency and multi-stress resilience under field conditions <i>Dr Marco Maccaferri</i> – Alma Mater Studiorum - Università di Bologna (UNIBO)
10:45 – 11:00	Genetic basis of wheat multi-stress resilience under sustainable management <i>Dr Delfina Barabeschi</i> - Council for Agricultural Research and Economics (CREA)
11:00 – 11:15	Genetic basis of grain quality stability <i>Dr Carlos Guzman</i> - Universidad de Cordoba
11:15 – 11:30	Assessing the impact of wheat genotype and biostimulants on agrobiodiversity under low input sustainable cultivation conditions <i>Prof Thomas Reitsch</i> - University of Copenhagen
11:30 – 11:45	Data Integration and modelling <i>Dr Tancredi Caruso</i> - University College Dublin
11:45 – 11:55	Management and communication <i>Prof Fiona Doohan</i> – University College Dublin
11:55 – 12:00	Closure

e.g. *TaFROG* enhances FHB resistance

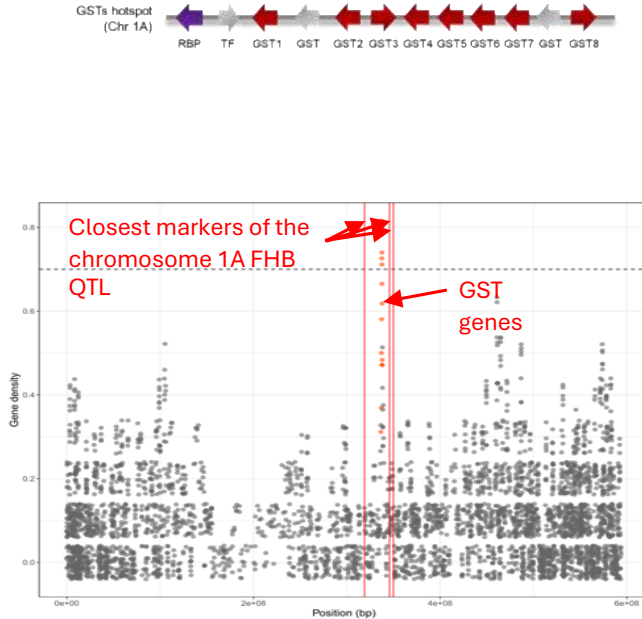


Effect of gene overexpression on FHB resistance of wheat cv. Fielder at 21 dpi



Perochon, A., Jianguang, J., Kahla, A., Arunachalam, C., Scofield, S.R., Bowden, S., Wallington, E. and Doohan, F.M., 2015. *TaFROG* encodes a Pooideae orphan protein that interacts with SnRK1 and enhances resistance to the mycotoxigenic fungus *Fusarium graminearum*. *Plant physiology*, 169(4), pp.2895-2906.

Identifying disease –responsive gene clusters e.g. GSTs cluster colocalises with a FHB QTL



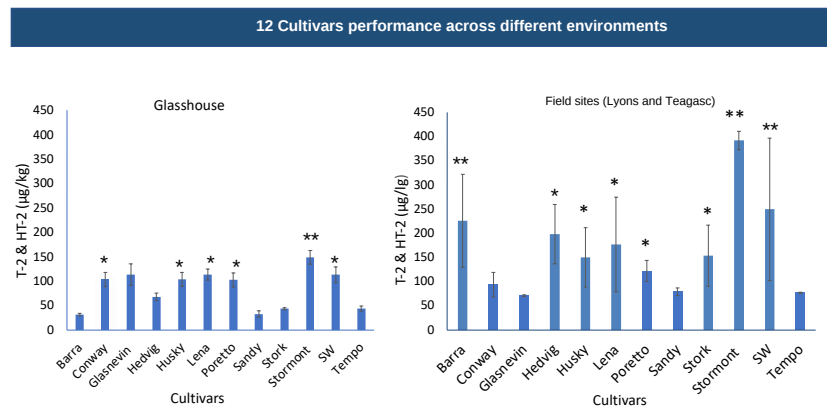
Scatter plot of *Fusarium* responsive gene density along the chromosome 1A and position of FHB resistance QTL *QFhbp-jaas.1AL*.

- Parologue (metabolic genes)
 - Glutathione-S-transferase (GST)
 - GST may play a role in FHB disease resistance
- GST Hotspot is within the QTL *QFhbp-jaas.1AL*.
- Hotspots may help to identify genes associated with FHB QTLs

Perochon, A., Benbow, H.R., Ślęczka-Brady, K., Malla, K.B. and Doohan, F.M., 2021. Analysis of the chromosomal clustering of *Fusarium*-responsive wheat genes uncovers new players in the defence against head blight disease. *Scientific Reports*, 11(1), p.7446.

Our oat work

- Deciphering the mechanisms of FI/T-2/HT-2 resistance –genes
- Biocontrol and biostimulation
- Breeding for healthy microbiomes
- HealthyOats – INTERREG 2020-2024
- Mycotox-I – UK-Ireland collaboration (DAFM/DAERA) 2022-2026
- OatFrontiers – NPA INTERREG 2022-2025
- E-Crop – biostimulants and biocontrol agents for oats – Enterprise Ireland funded 2022-2025



GWAS

- Looking for markers linked to low mycotoxins

Isidro-Sánchez, J., D'Arcy Cusack, K., Verheecke-Vaessen, C., Kahla, A., Bekel, W., Doohan, F., Magan, N., Medina, A. 2020. Genome-wide association mapping of *Fusarium langsethiae* infection and mycotoxin accumulation in oat (*Avena sativa* L.). Plant Genome 13: e20023.

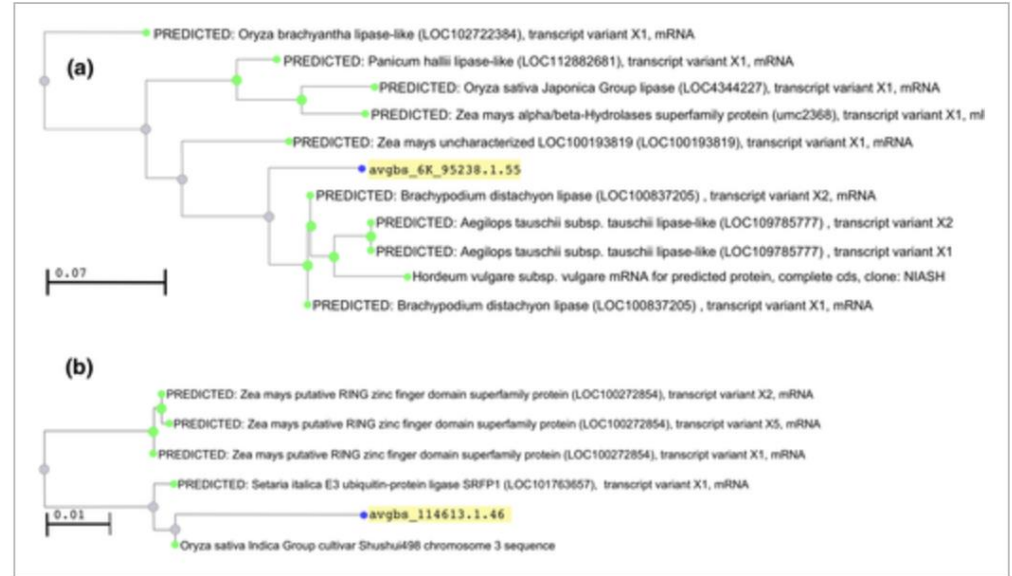


FIGURE 4

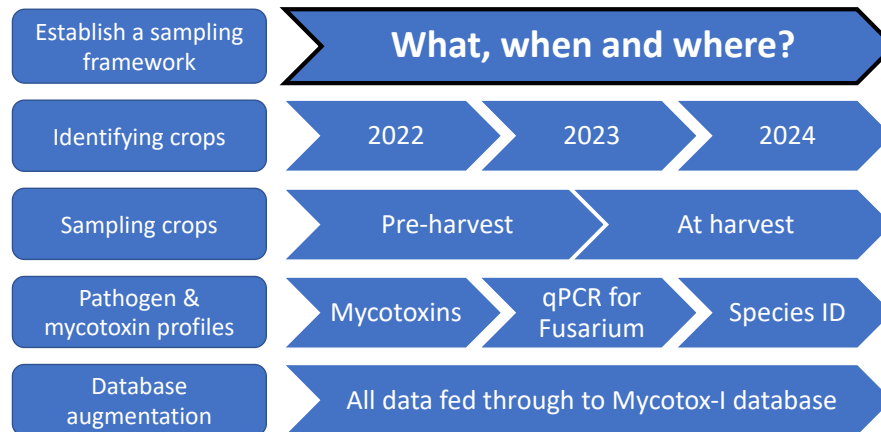
[Open in figure viewer](#)

Dendrograms for two significant markers detected in this analysis; (a) *avgbs_6K_95238.1.55* and (b) *avgbs_114613.1.46*. The predicted protein is a lipase (class 3) (Matsumoto et al., 2011).

Dendrograms were constructed using NCBI Genome Workbench version 2.13.0

Mycotox-I...

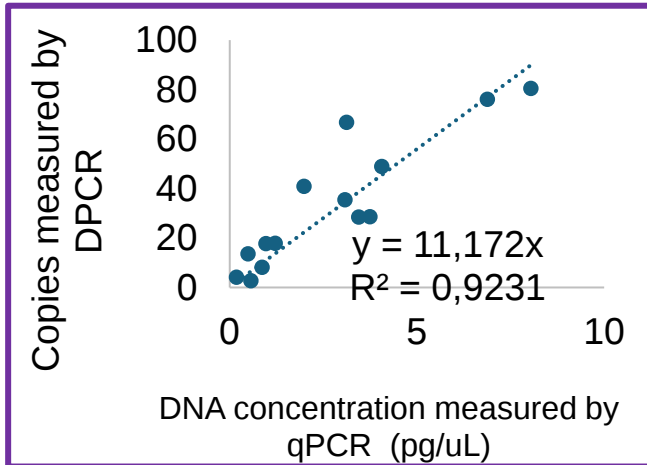
Field experiments, glasshouse experiments, farm sampling



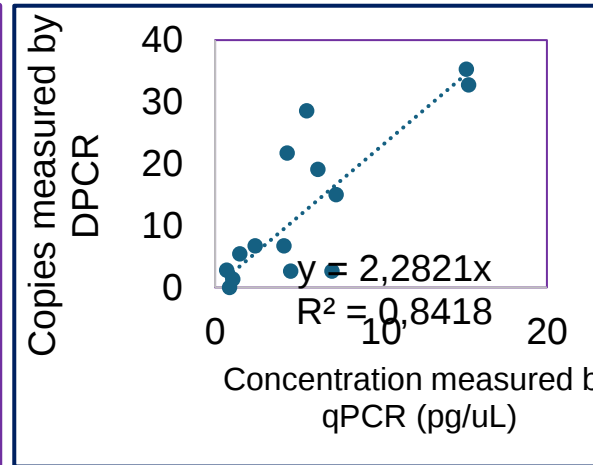
2025/6: Machine learning incorporates all data to develop decision support model

Correlation between qPCR and dPCR using field samples

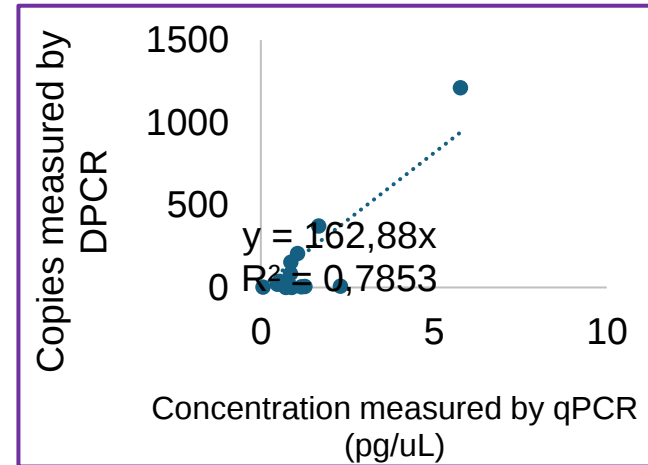
Tri5 assay



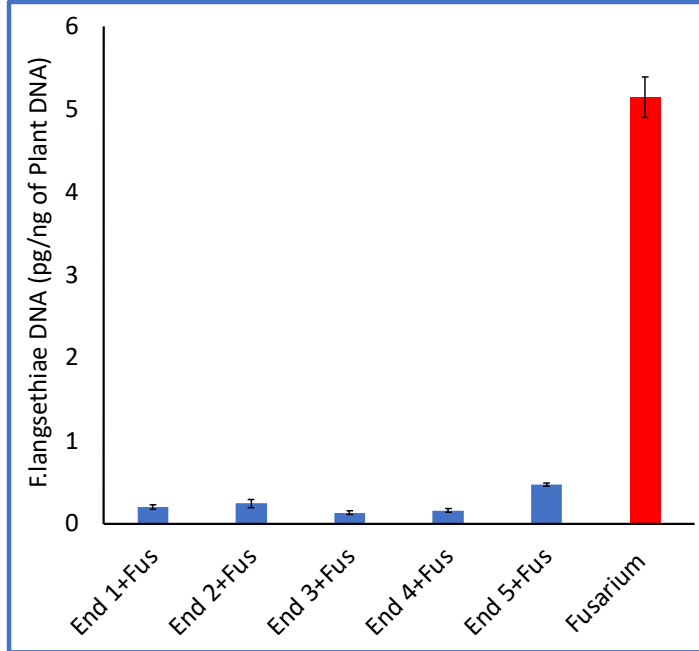
F. poae specific assay



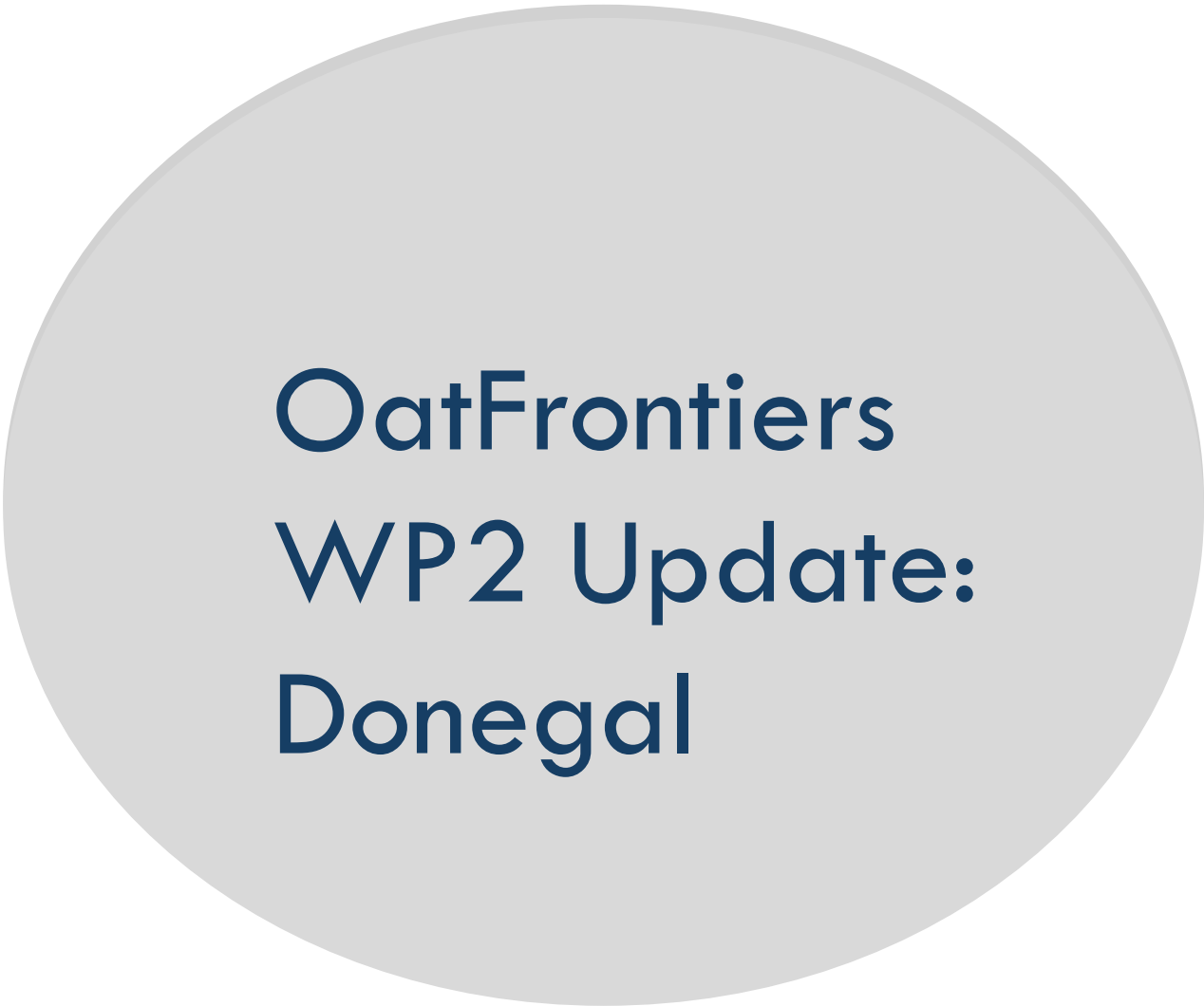
F. langsethiae specific assay



E-Crop: biocontrol



Treatment	T2 toxin (µg/kg)	Ht-2 toxin (µg/kg)
End 1 + F.lang	<10	<10
End 2 + F.lang	<10	<10
End 3 + F.lang	<10	<10
End 4 + F.lang	<10	<10
End 5 + F.lang	<10	<10
Control	37 ± 8.7	253 ± 68



OatFrontiers

WP2 Update:

Donegal

Why Donegal

- Agriculture in the Northwest of Ireland is primarily based around livestock production
- Traditionally, oats were widely grown in this area
 - Highly suitable soil type
 - Climatic challenges
- Can we find more suitable resilient varieties for these areas?



Work Package Objectives

Evaluate diverse, elite germplasm under unique agro-climatic conditions

Phenotypic evaluation of NMBU population

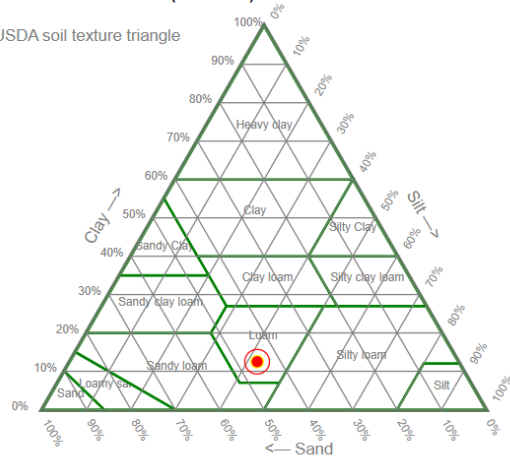
Identification and quantification of *Fusarium* resistance in elite oat germplasm (Collaboration with Teagasc)

Site Location

- Newtowncunningham, Co. Donegal
- Soil type-Ballywilliam

TOPSOIL ATTRIBUTES (Horizon 1)

USDA soil texture triangle

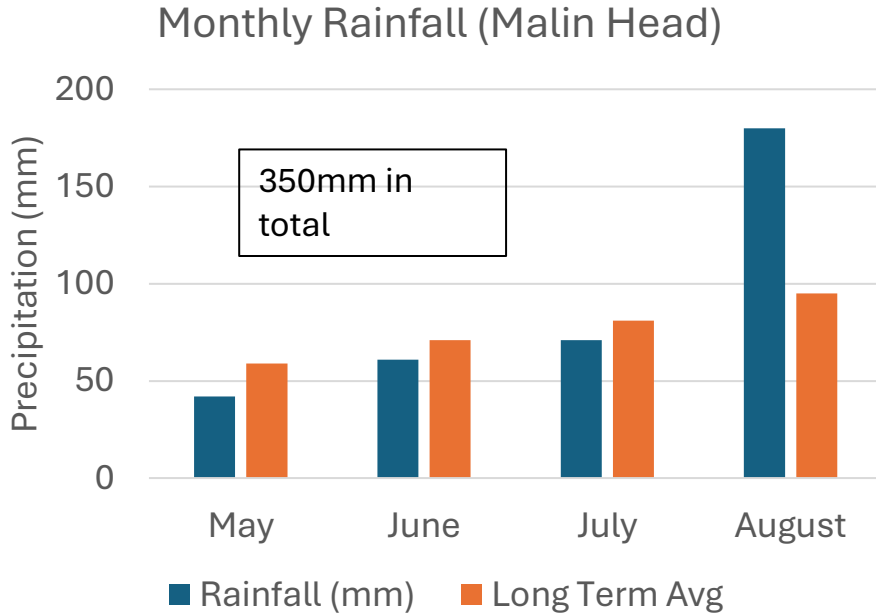


Loam-type soil

45% Sand
45% Silt
10% Clay



Growing conditions



- Sowing date (9 May 2024)
- Fertilizer (350 kg /ha – 17-6-17)
 - 60 kg N/ha
 - 20 kg P/ha
 - 60 kg K/ha
- Highly fertile site (2 years out of grass ley)
- Weed control (standard)
 - Cameo max 60g/ha + Hurler 0.75 l/ha
- No Fungicides/PGR's applied

Variety

Niklas (Finland)

Akseli (Finland)

Perttu (Finland)

Nella (Finland)

Meeri (Finland)

Oiva (Finland)

Sang (Sweden)

Belinda (Sweden)

Galant (Sweden)

Cilla (Sweden)

Fatima (Sweden)

Hera (Sweden)

Bettina (Sweden)

Odal (Norway)

Haga (Norway)

Husky (Nordsaat/Ireland)

WPB Isabel (Ireland)

Barra (Ireland)

Magellan (KWS/Germany)

Oliver (Selgen/France (naked))

070-SO2011Au5 (IBERS, Wales/Welsh)

TIMPANI (Welsh)

Conway (Welsh)

Raven (Norway)

Dovre (Norway)

Ringsaker (Norway)

Avetron (Norway)

Hurja (Norway)

Pol (Norway)

Nova (Iceland)

Data collected

Agronomy

- Plant count
- Days to heading
- Days to flowering
- Plant height
- Lodging area
- Lodging angle

Disease

- Powdery mildew
- Crown rust

Field preparation



22 May 2024

Emergence



Assessment (e.g. 21 August 2024)



Lodging

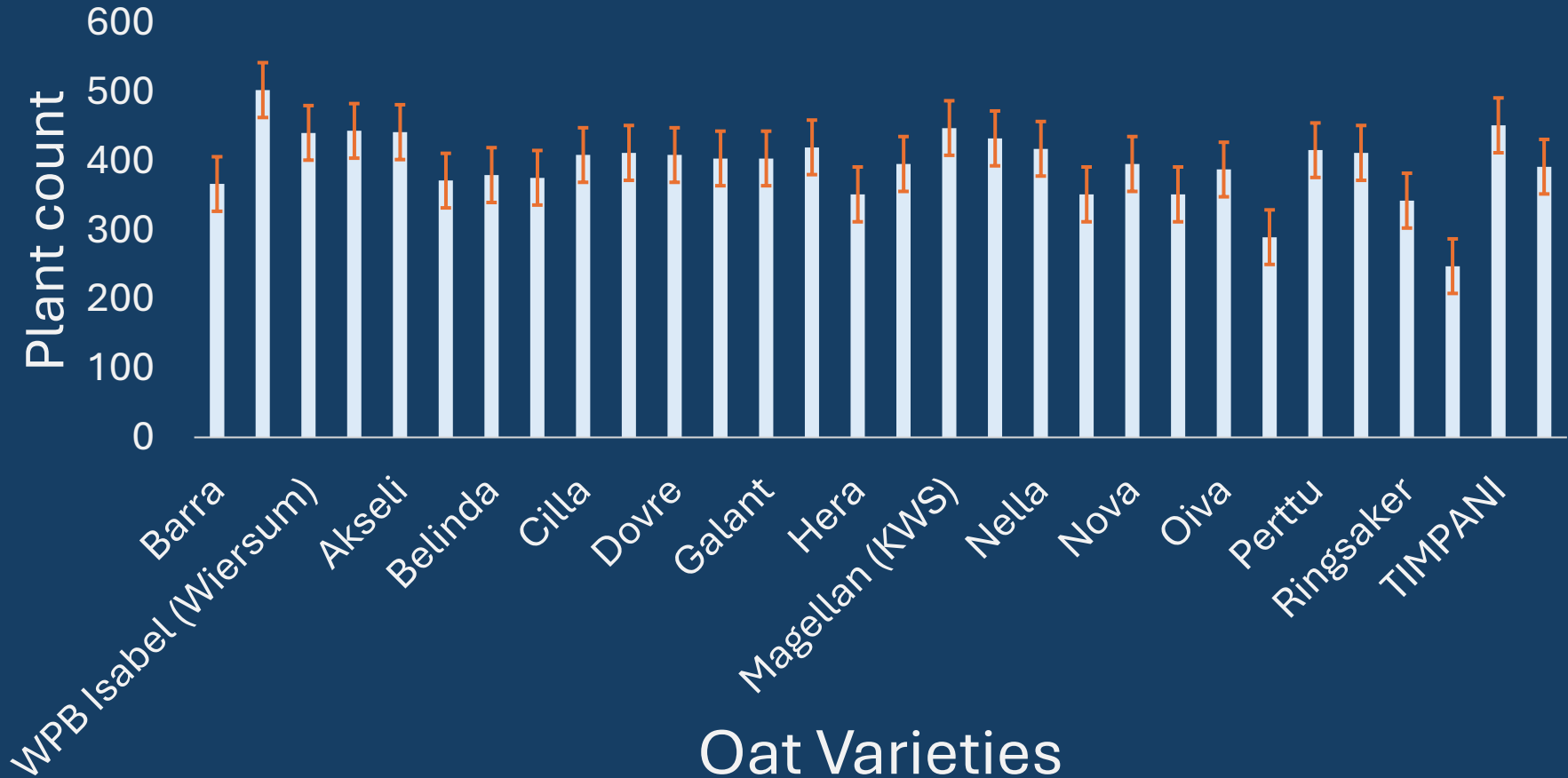
(19 Sep 2024)



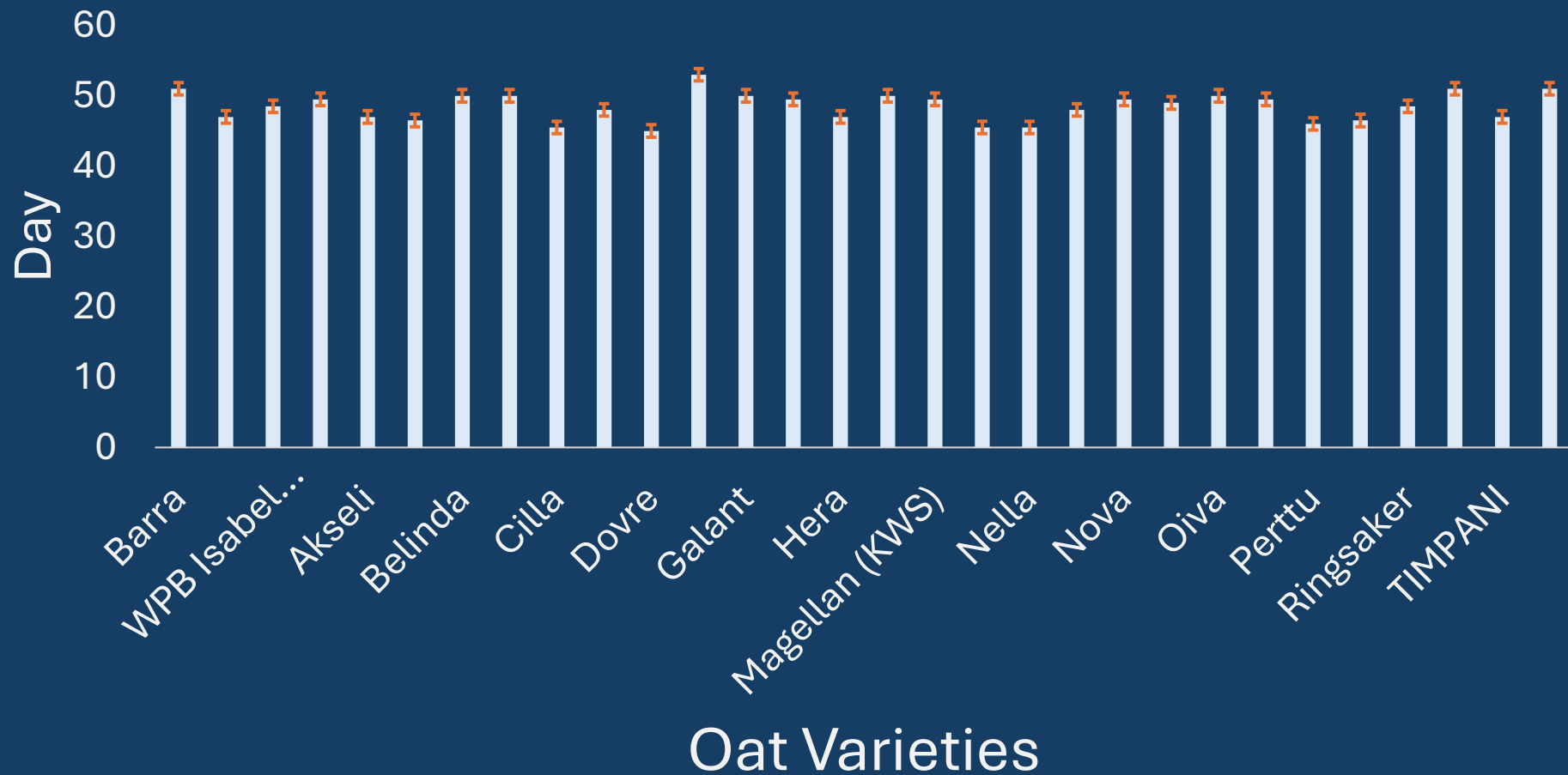
Results

Big Plots

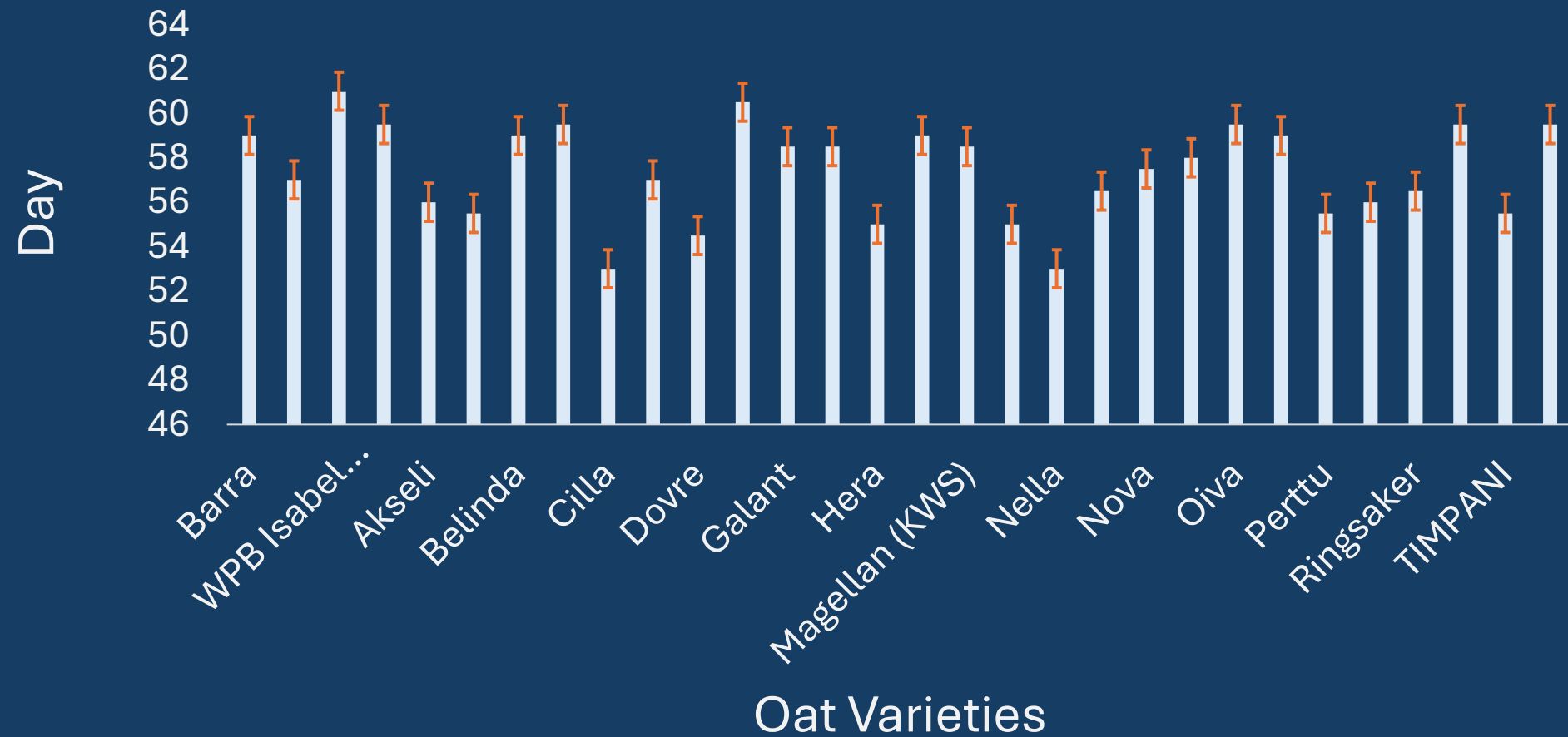
Plant Count



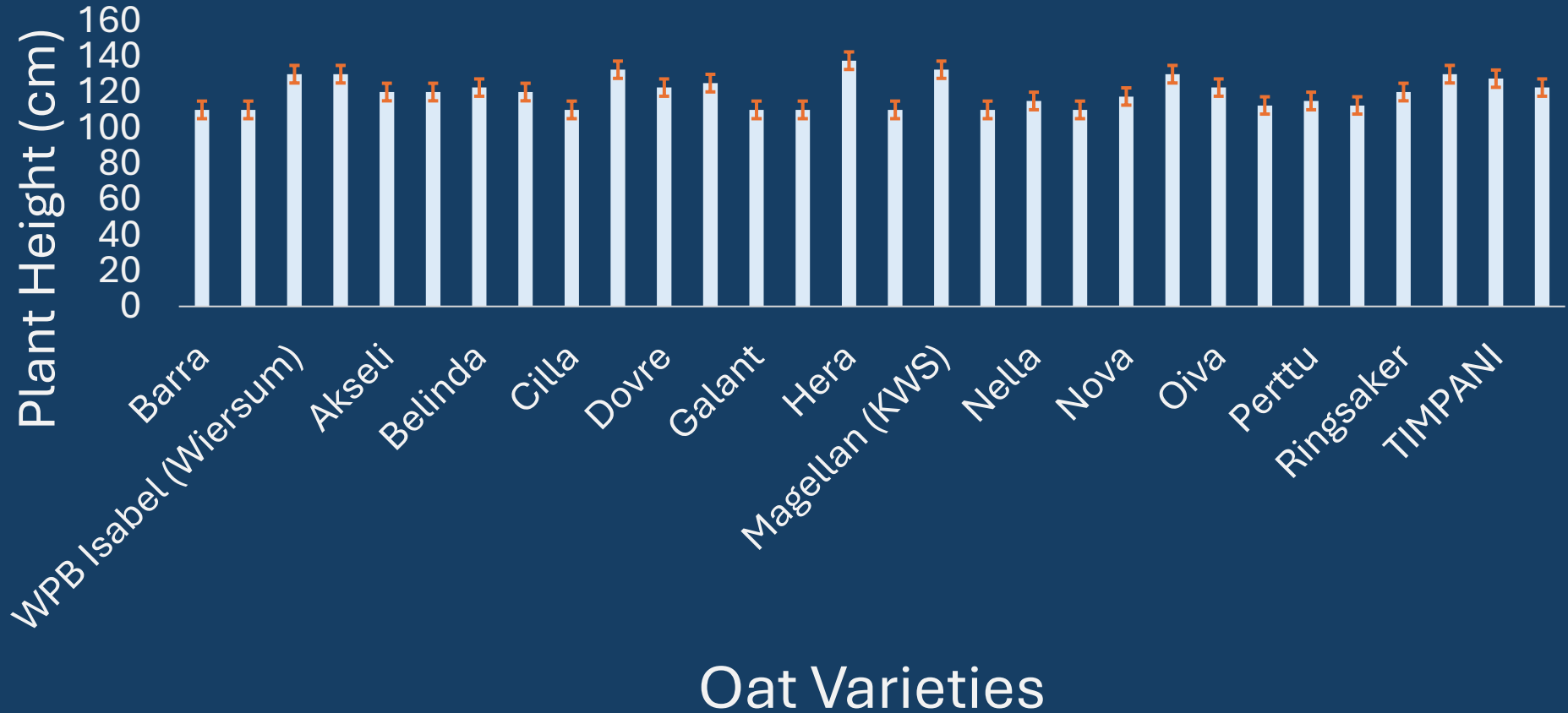
Days to Heading



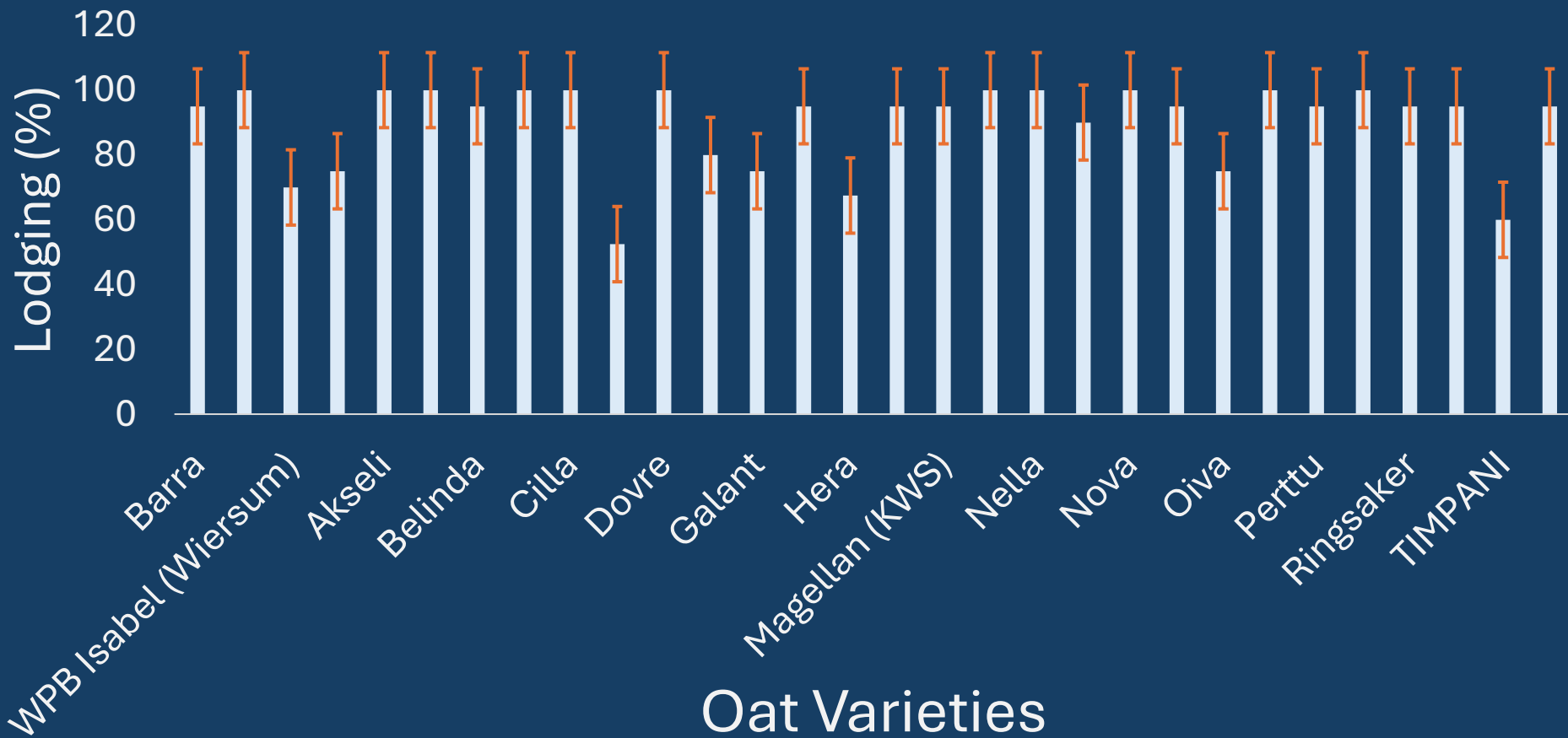
Days to Flowering



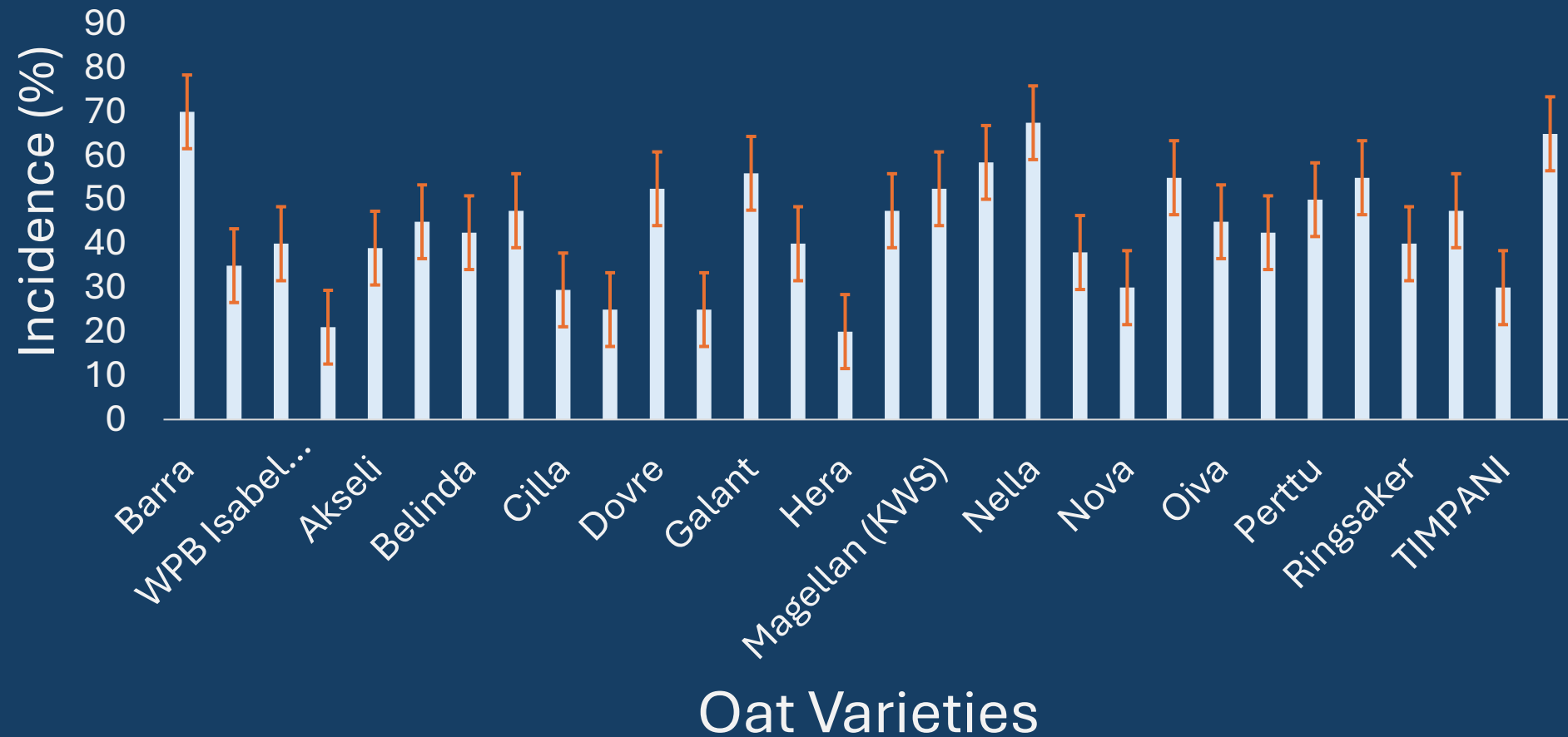
Plant Height



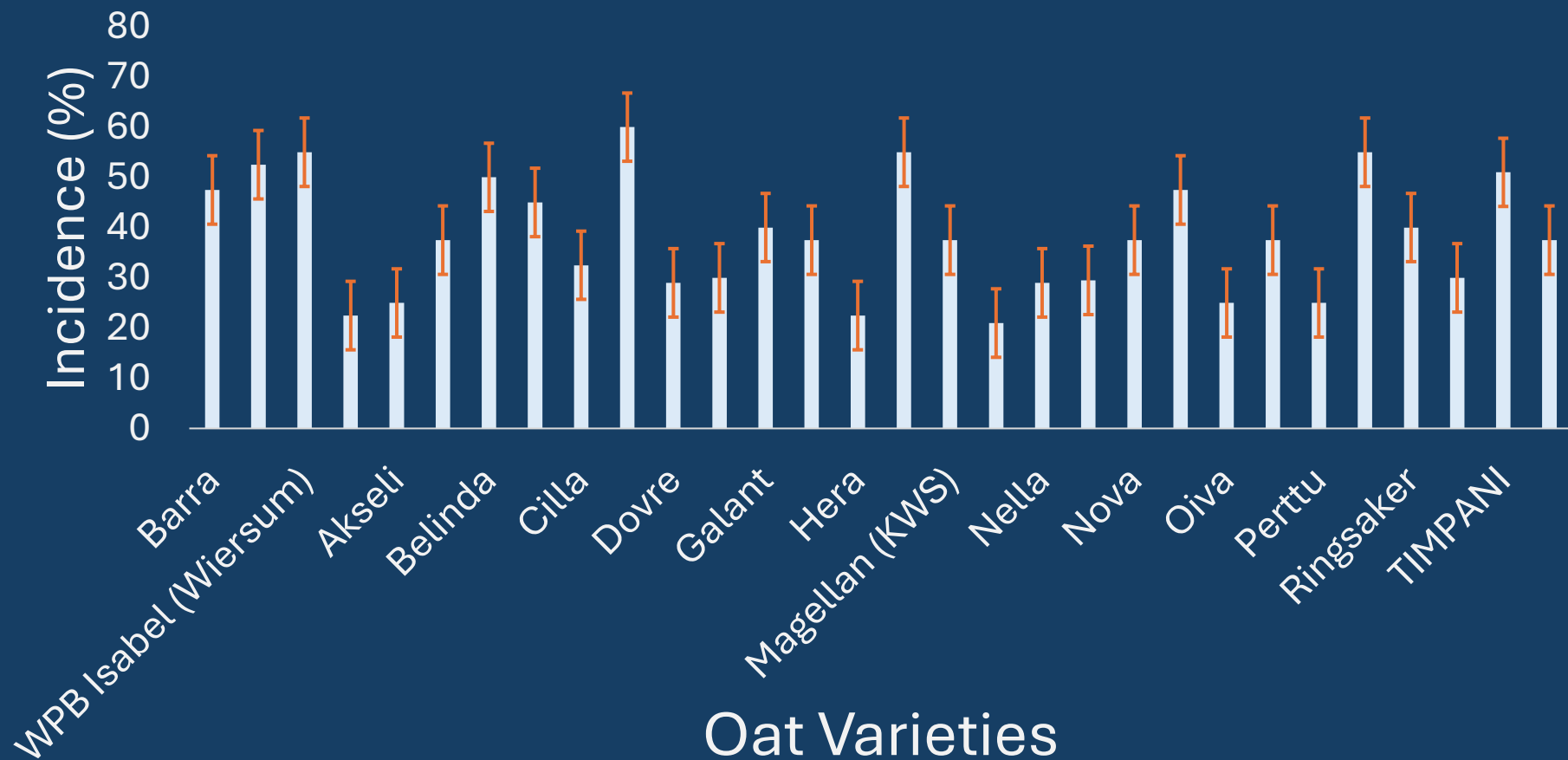
Lodging



Powdery Mildew



Crown Rust



Harvest/Grain quality analysis

- Hoping to harvest on October 2/3rd
- Grain quality analysis will follow as per protocol

Row/Hill plots

- Full phenotypic evaluation as per protocol
- High lodging levels
- Interesting variation in maturity, height and crown rust/mildew resistance

FHB trials

- Field and glasshouse
 - 28 common varieties
 - Inoculated 5 heads per variety with *Fl* in the field in both Donegal and Carlow (Teagasc)
 - Harvested
 - Will mill by March and do mycotoxin analysis – may 2025
 - Glasshouse – two FHB experiments with *Fl*, another in 2025

Current team members

Suzan Bhadbury
Sai Sushma Boggarapu
Alessia Confortini
Conor Copeland
Sinead Dermody
Musfirah Mansoor
Abhishek Singh

Farhana Afroze
Minely Ceron

Natarajan Subramani

Ganesh Thapa

Nikita Botvich
Thalia Christapoulos
Kani Ravichandran

Ivy Marajas

John Kennedy

Many past team members

Israel Ikoyi, Andrea Manzoni,
Daniel Belliany, Sobia Ajaz,
Chan Arunachalam, Harriet
Benbow, Ciaran Brennan,
Myriam Deshaies, Amelie
Heckmann, Amal Kahla,
Keshav Malla, Alex Perochon
Katarzyna Slecza., Ashok
Govindan, Ganesh Thapa
Binbin Zhou, Enrique Alcaide

Collaborators

THE OATFRONTIER TEAM!

Aberystwyth University: Catherine Howarth, John Doonan

UCD: Angela Feechan, Tancredi Caruso, Tom McCabe, Julio Sanchez, Dolores O-Riordan, Amalia Scannell, Saoirse Tracy

Teagasc: Ewen Mullins, Steven Kildea, Atikur Rahman, Susanne Barth, John Spink, Dheeraj Rhatore

QUB: Brett Greer, Chris Elliott

AFBI: Lisa Black, Elizabeth Magowan

TCD: Trevor Hodgkinson, Brian Murphy

Rothamsted Research, UK: Nigel Halford, Matthew Paul,

National Institute of Botany UK: Emma Wallington

U. of Bologna: Marco Maccaferri, Roberto Tuberoso

ICARDA: Sripada Udupa

U. of Minnesota: David Garvin

John Innes Centre, UK: Cristobal Uauy, Paul Nicholson, Simon Griffiths, Noam Chayut

U. of Copenhagen: David Collinge, Hans Jorgensen, UOC



CropBiome
Origin Enterprises

Northern Periphery and Arctic

