Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

TARGETING IMPROVED PARTIAL RESISTANCE USING YIELD LOSS RESPONSE CURVES FOR FOLIAR DISEASES OF WHEAT

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GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Queensland Government
NSW GOVERNMENT Department of Primary Industries
AGRICULTURE VICTORIA
SAGI
Statistics for the Australian Grains Industry

NATIONAL PROJECT - YIELD LOSS RESPONSE CURVES FOR HOST RESISTANCE TO LEAF, CROWN AND ROOT DISEASES IN WHEAT AND BARLEY (2014-19)

Project Modules and Module Leaders

1. Project leadership – DPIRD (Dr R Loughman)
2. Data analysis – QDAF (Dr A Kelly)
3. Crown rot – DPINSW (Dr S Simpfendorfer)
4. Root lesion nematodes (RLN) – AGVIC (Dr G Hollaway)
5. **Wheat foliar – DPIRD (Dr M Shankar)**
6. Barley foliar – QDAF (Mr G Platz)

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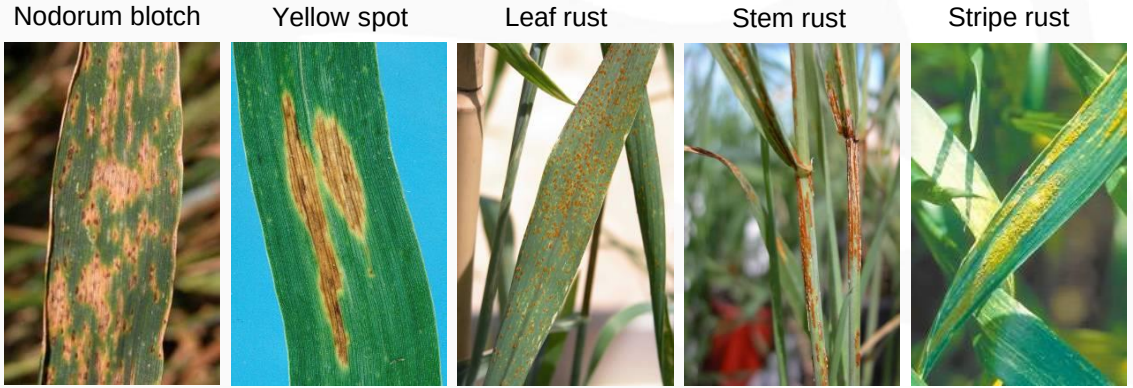
WHEAT FOLIAR MODULE

Background: Cultivar resistance ratings provide critical information but less is known about yield losses from diseases under different partial resistance scenarios.

Aim: To develop yield response curves indicating potential losses associated with various resistance categories for 5 key foliar diseases of wheat:

1. Nodorum blotch (*syn*. Septoria nodorum blotch)
2. Yellow spot
3. Leaf rust
4. Stem rust
5. Stripe rust



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31 TRIALS CONDUCTED NATIONALLY AND A MET ANALYSIS COMPLETED FOR EACH DISEASE

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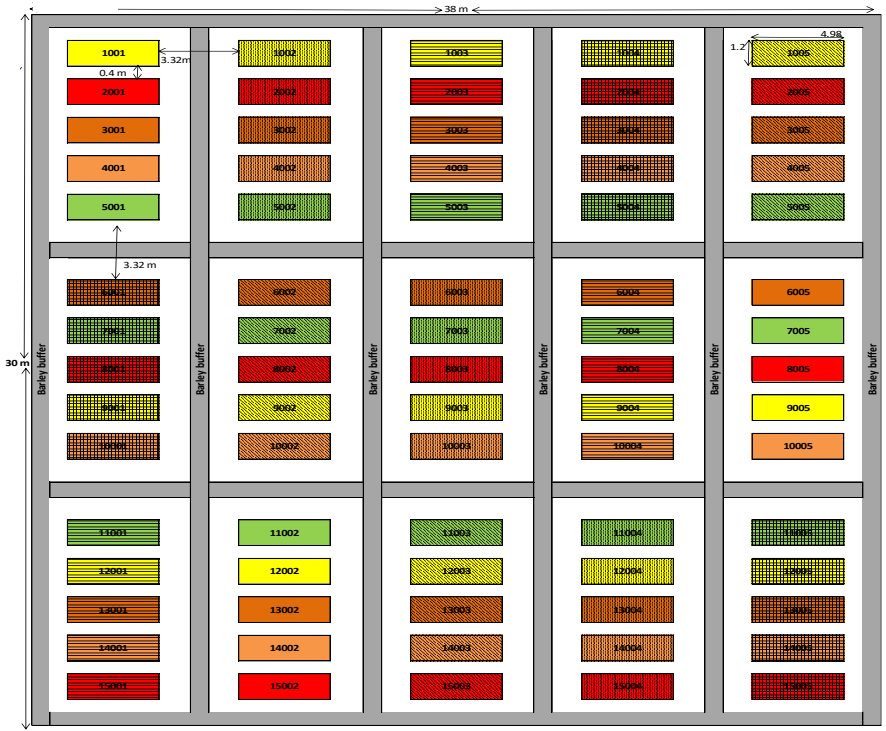
Disease	Trials 2015	Trials 2016	Trials 2017	Trials 2018	Disease Establishment
Nodorum blotch (WNB)	WA	WA	WA	WA	Spore suspensions
Yellow spot (WYS)	QLD, SNSW, VIC, WA	QLD, SNSW, VIC, WA	QLD, WA		Spore suspensions / Infected stubble
Leaf rust (WLR)	QLD, VIC, WA	QLD, VIC, WA	QLD, VIC, WA	QLD, WA	Infected transplants and spore suspensions
Stem rust (WSR)	WA	WA	WA	WA	Infected transplants and spore suspensions
Stripe rust (WYR)	SNSW	SNSW			Infected transplants and spore suspensions

TRIAL DESIGN

A strip-plot design with 5 varieties × 5 disease levels × 3 reps



Variety
MRMS
MS
MSS
S
SVS

Varieties selected:

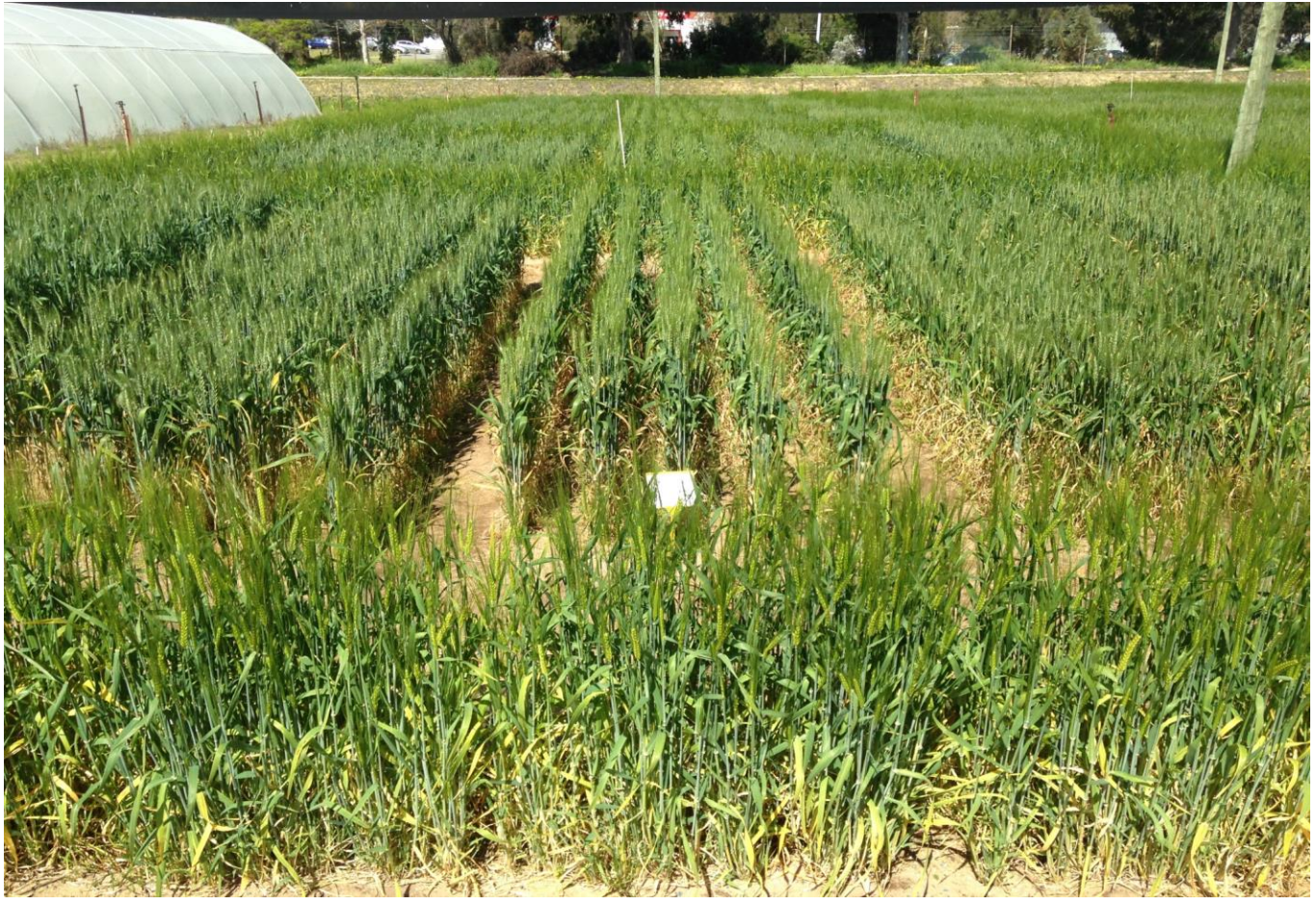
- represented a range of resistances
- were adapted to the particular region
- had similar maturities
- were resistant to diseases which are potential contaminants

Epidemic
Very High Disease Pressure (VHDP)
High Disease Pressure (HDP)
Medium Disease Pressure (MDP)
Low Disease Pressure (LDP)
Total Protection (TP)

Different epidemic levels obtained by varying the:

- spore concentration
- amount of stubble
- number and concentration of fungicide sprays

2016 NODORUM BLOTCH TRIAL – SOUTH PERTH



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2016 NODORUM BLOTCH TRIAL SOUTH PERTH, WA

Disease Assessment

High Disease Pressure

Fungicide Protected

- Good establishment of disease with various epidemic levels well distinguished.
- Disease expression was measured on multiple dates starting from flag leaf emergence.
- Two upper leaf layers of 10 random plants per plot were assessed.

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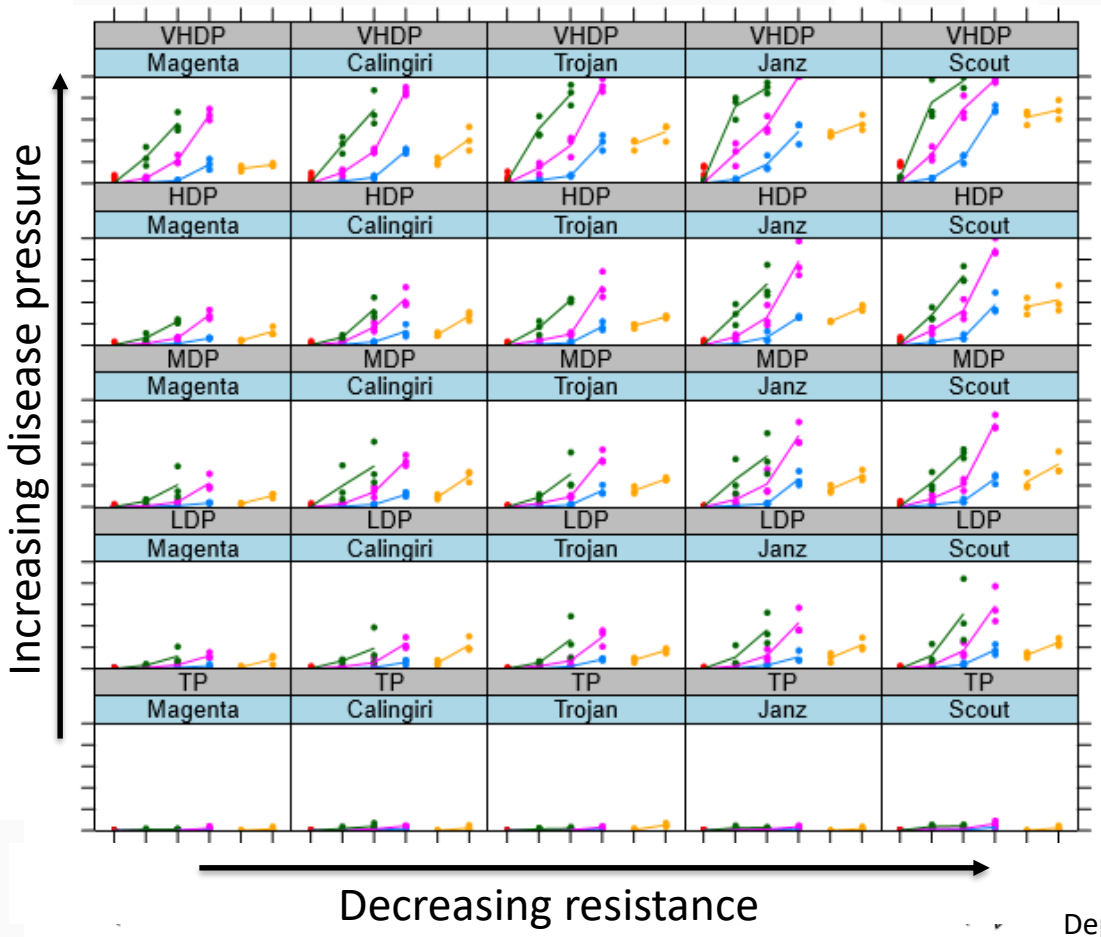
2016 NODORUM BLOTCH TRIAL SOUTH PERTH, WA

Progressive disease development with time



- Disease levels well distinguished
- Resistance categories well reflected

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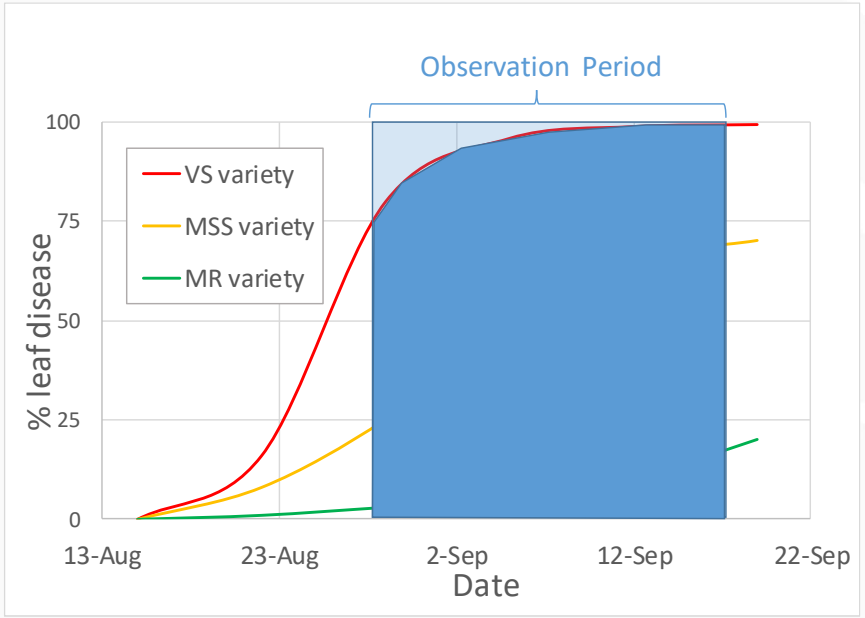
CUMULATIVE DISEASE EXPRESSION ACROSS TIME ON FLAG AND FLAG-1

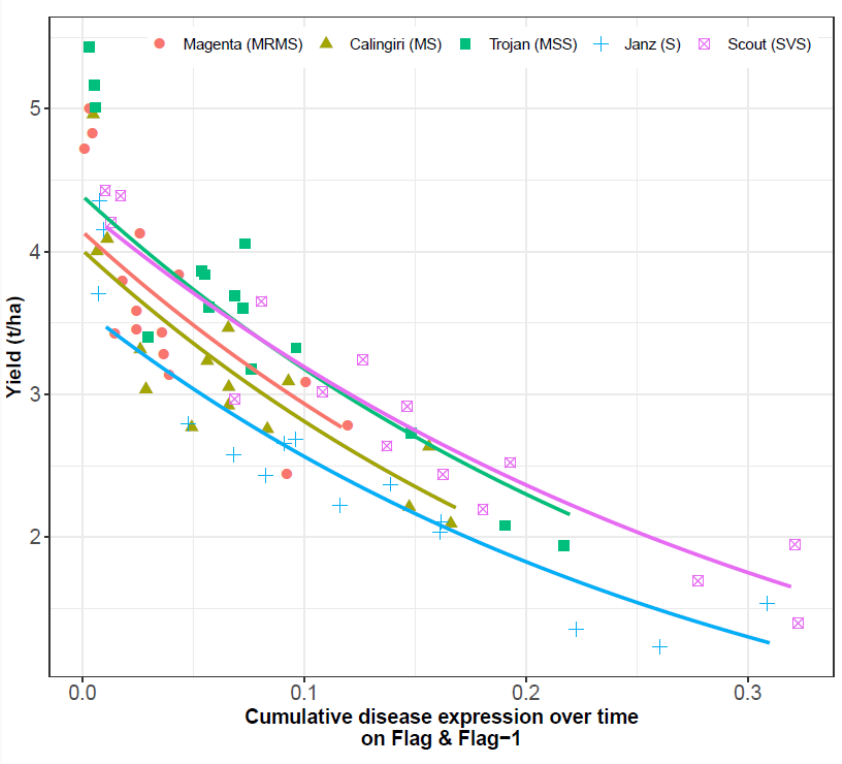


Relative area under the disease progress curve (rAUDPC)

- The cumulative disease expression across time was calculated at the plot level as the relative area under the disease progress curve (rAUDPC).
- rAUDPC is the proportion of the dark blue shaded area below the curve.

2016 NODORUM BLOTCH TRIAL SOUTH PERTH, WA

Yield loss response curves



- All varieties had the same slope indicating the same rate of disease development.
- Resistance was expressed as shorter curves indicating lower disease expression and lower yield loss.
- Yields of disease-protected plots was between 3.5 to 4.4 t/ha.
- Highly susceptible varieties lost between 2.3 to 2.7 t/ha.
- A partially resistant variety expressed lower burdens of total disease and lost 1.4 t/ha.
- Partial resistance to nodorum blotch reduced yield loss by around 40 to 47% of losses observed in S/SVS varieties.

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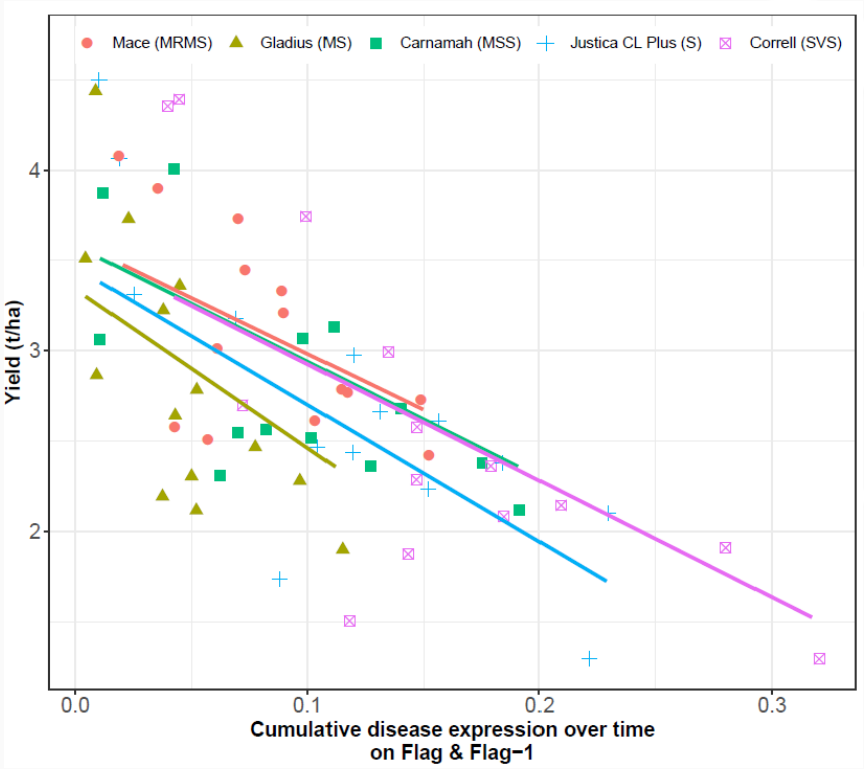
2016 YELLOW SPOT TRIAL SOUTH PERTH, WA

Yield loss response curves



Yield loss reduction due to partial resistance to yellow spot - **46 to 50%**

High Disease Pressure

Fungicide Protected

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RUST TRIALS

Yield loss response curves

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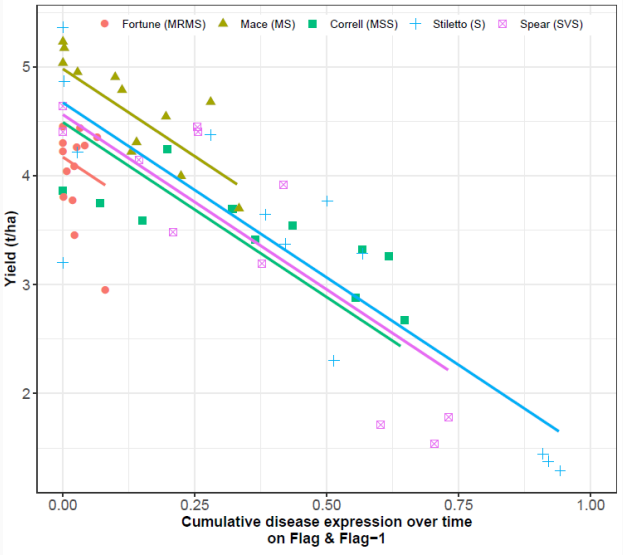
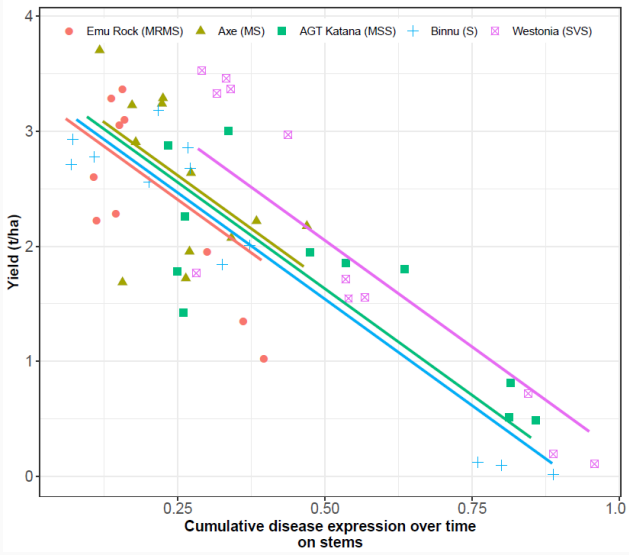
2016 Leaf rust Carnarvon, WA



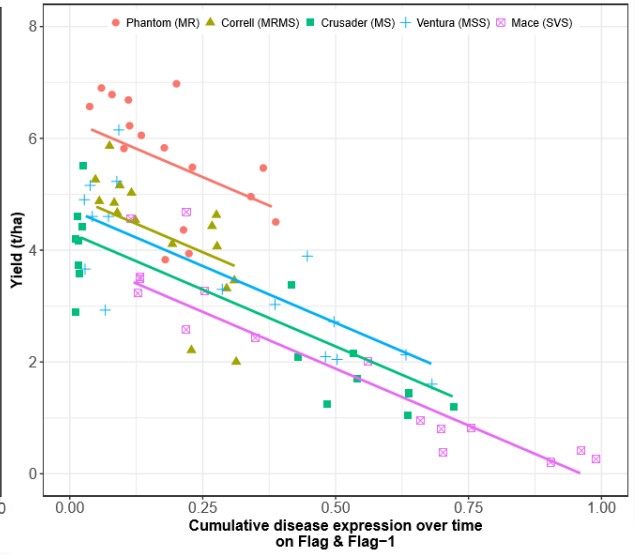
Yield loss reduction due to partial resistance to leaf rust - **65 to 89%**

2015 Stem rust Carnarvon, WA



Yield loss reduction due to partial resistance to stem rust - **50 to 57%**

2016 Stripe rust Wagga Wagga, NSW



Yield loss reduction due to partial resistance to stripe rust - **59%**

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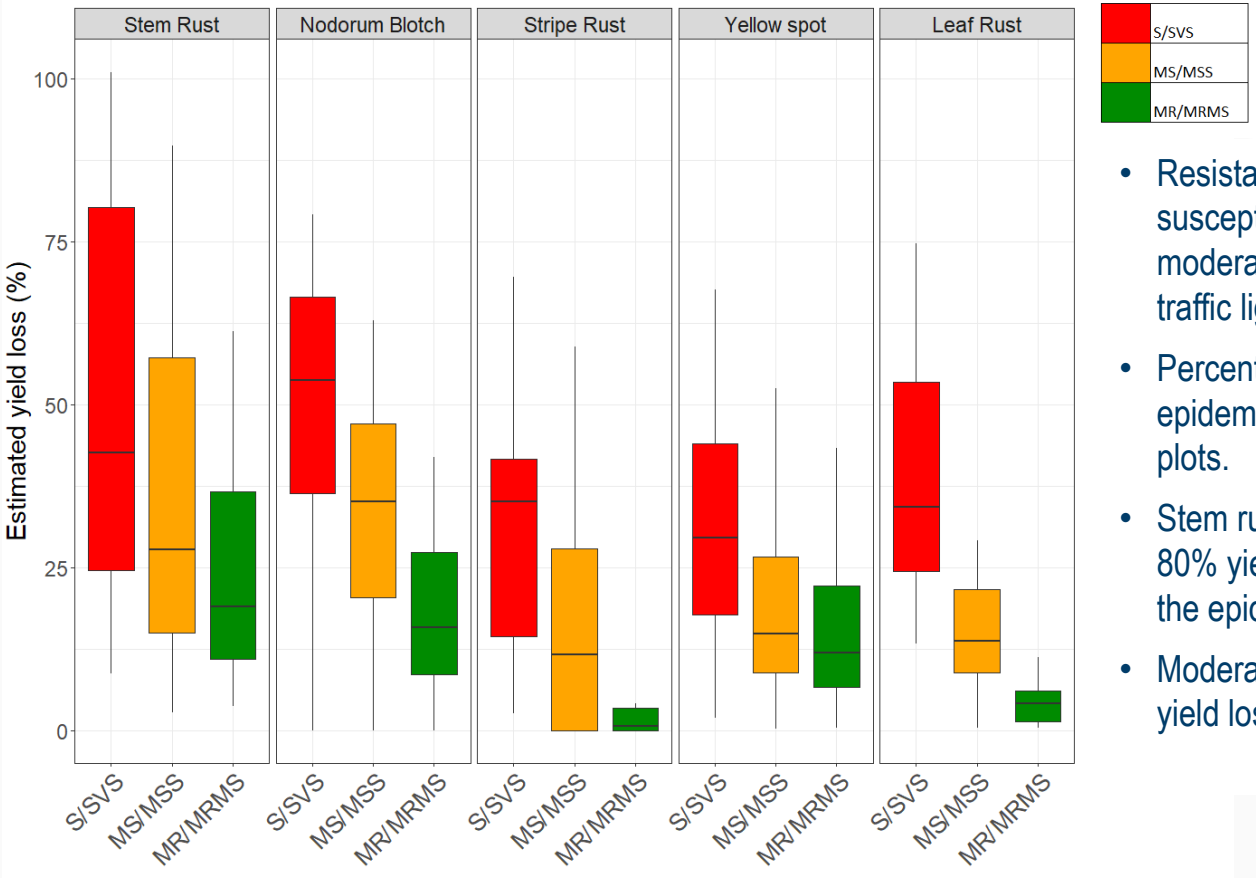
RANGE OF PERCENTAGE LOSS CAUSED BY VARIOUS DISEASES



- Resistance ratings grouped into 3 categories of susceptible (S/SVS), intermediate (MS/MSS) and moderately resistant (MR/MRMS) represented by traffic light signals.
- Percentage yield loss observed in various disease epidemic level plots relative to yields in protected plots.
- Stem rust was most damaging resulting in 25% to 80% yield loss for susceptible varieties depending on the epidemic level.
- Moderate resistance was highly effective in reducing yield loss for leaf rust and stripe rust.

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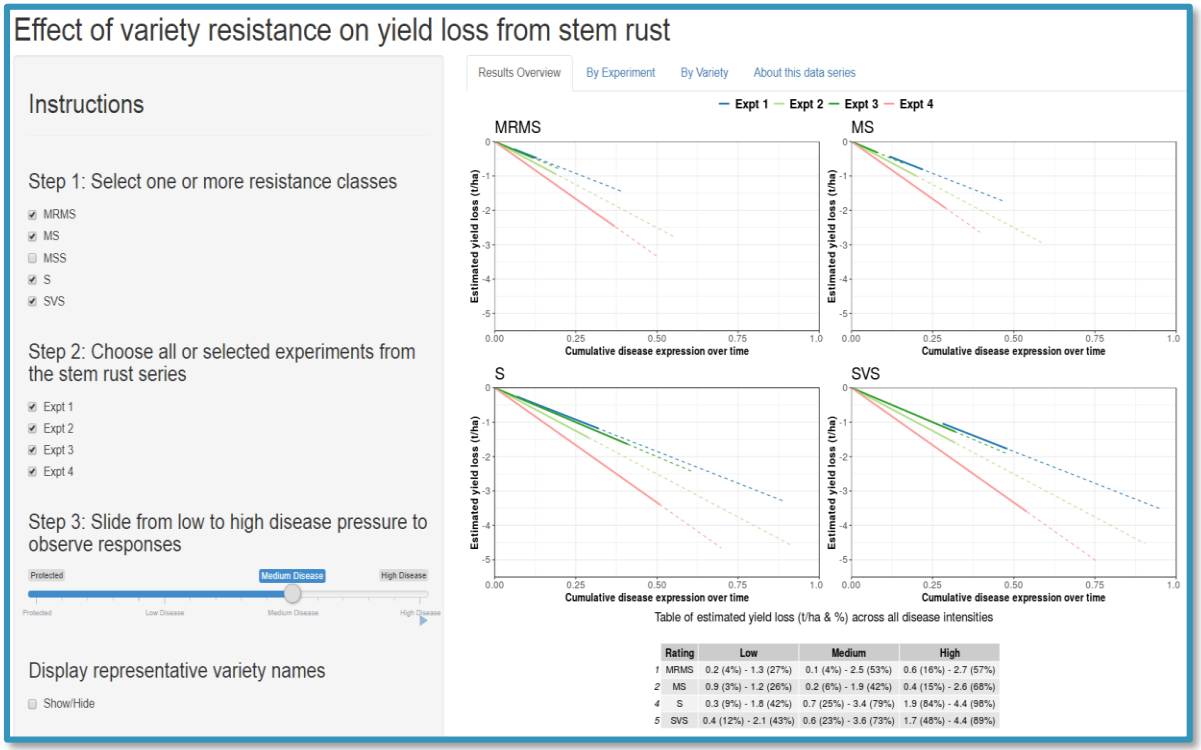
YIELD LOSS TO DISEASE - ONLINE VISUALISATION MODEL

Developed by Zanglong Cao (SAGI-West) and Karyn Reeves (DPIRD)

A prototype for wheat foliar diseases soft launched at 2020 Research Updates - On display at the DPIRD booth

Feedback requested so the new tool can be refined before an official release next year

- Interactive visualisation model
  - MET derived
  - Examines yield loss dynamics
- Select
  - Resistance classes
  - Environments
  - Disease pressure
- Layered by disease
  - MET based overview
  - Individual experiments
  - Individual varieties
  - Graphs, tables
- To be expanded to
  - 14 foliar and root diseases of wheat and barley



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CONCLUSIONS

- This study provides the first set of definitive results demonstrating yield loss responses to wheat foliar diseases as influenced by partial resistance, epidemic intensity and environment.
- Partial resistance was effective in reducing losses from all diseases for current commercial wheat varieties.
- An online model has been developed so growers and consultants can make more informed decisions about variety selection by comparing yield responses to various resistance categories of individual diseases.

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