An evaluation of recent trends in nitrogen use efficiency of UK wheat

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WGIN Stakeholders 2021

The trials

- A core WGIN study

- 2004 to present, 17 years, at Rothamsted farm

- >71 varieties, core of 14

- 4 N-rates most years

- Targeting modern genetic diversity

- Many spin off projects

# Main objectives for this report

1. Compile datasets for the WGIN trials over the past 16 years (2004-2019)

2. Derive Nitrogen Use Efficiency (NUE) performance parameters for the datasets

3. Perform statistical analysis to determine significant trends :

    (a) year of variety introduction to assess crop breeding impacts, and nabim group

    (b) year the trial was performed (from 2004 to 2019 harvests), to determine time dependent trends as influenced by climate or management practice

    (c) trait stability

    (d) relationships of key weather variables influencing performance over the period of the trials
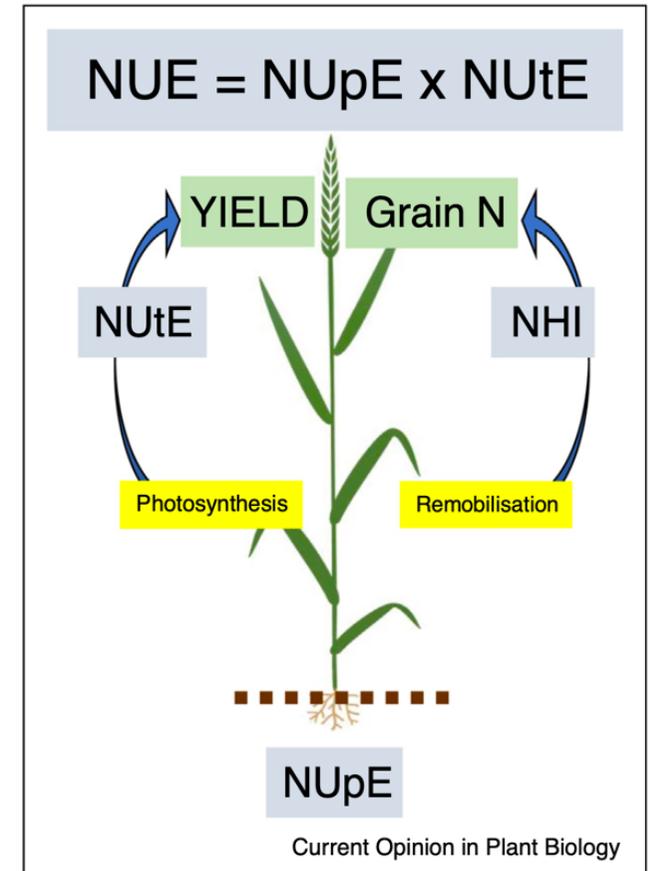
UK farm gate yield trends
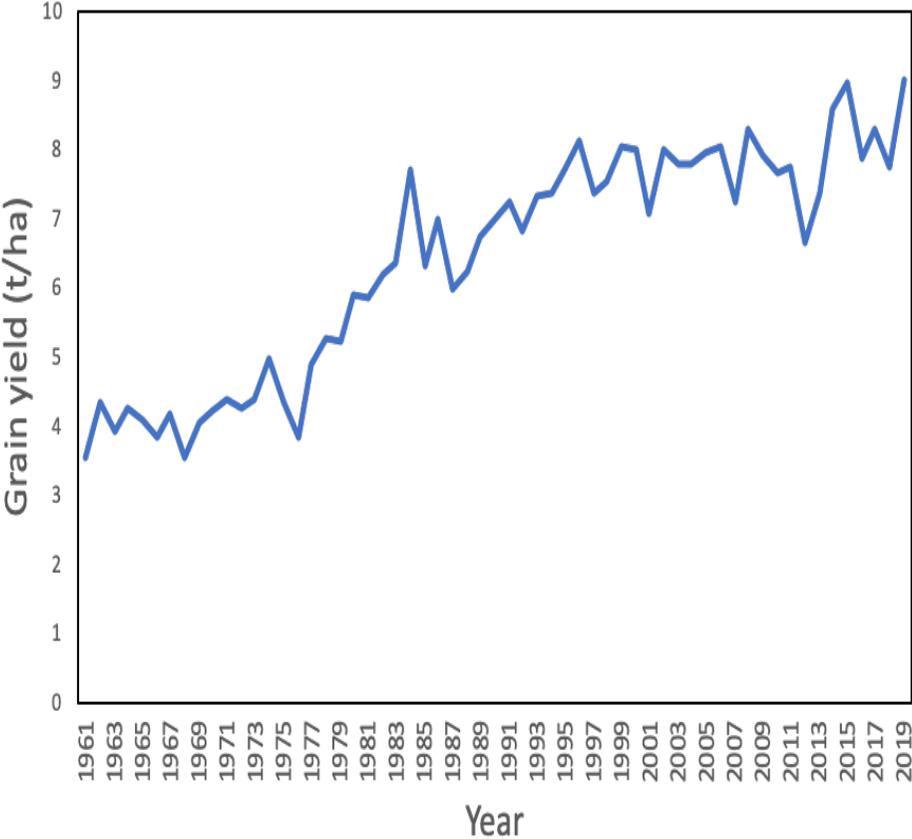
# WGIN trial yield trends
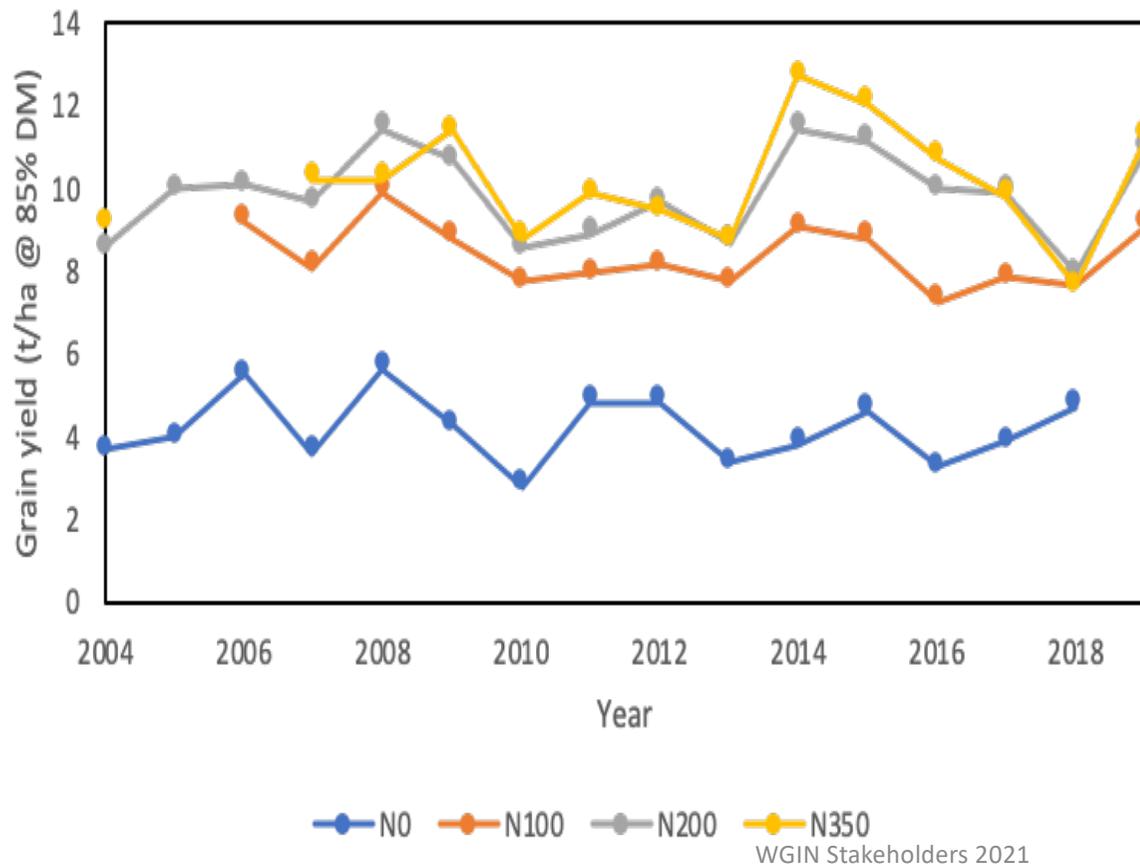
What is nitrogen use efficiency?

- Response to added N
- Nitrogen capture: minimal losses of applied fertilizer
- Maximum yield from applied N
- Grain N

- Uptake efficiency (N recovery)
- Utilization efficiency (yield for N taken up)
- NUE = NUpE x NUtE (yield for N available)

$$NUE = NUpE \times NUtE$$

YIELD   Grain N

NUtE   NHI

Photosynthesis   Remobilisation

NUpE

Current Opinion in Plant Biology

Hawkesford MJ, Griffiths S (2019) Exploiting genetic variation in nitrogen use efficiency for cereal crop improvement. *Current Opinion in Plant Biology* **49**, 35–42. (doi: 10.1016/j.pbi.2019.05.003).
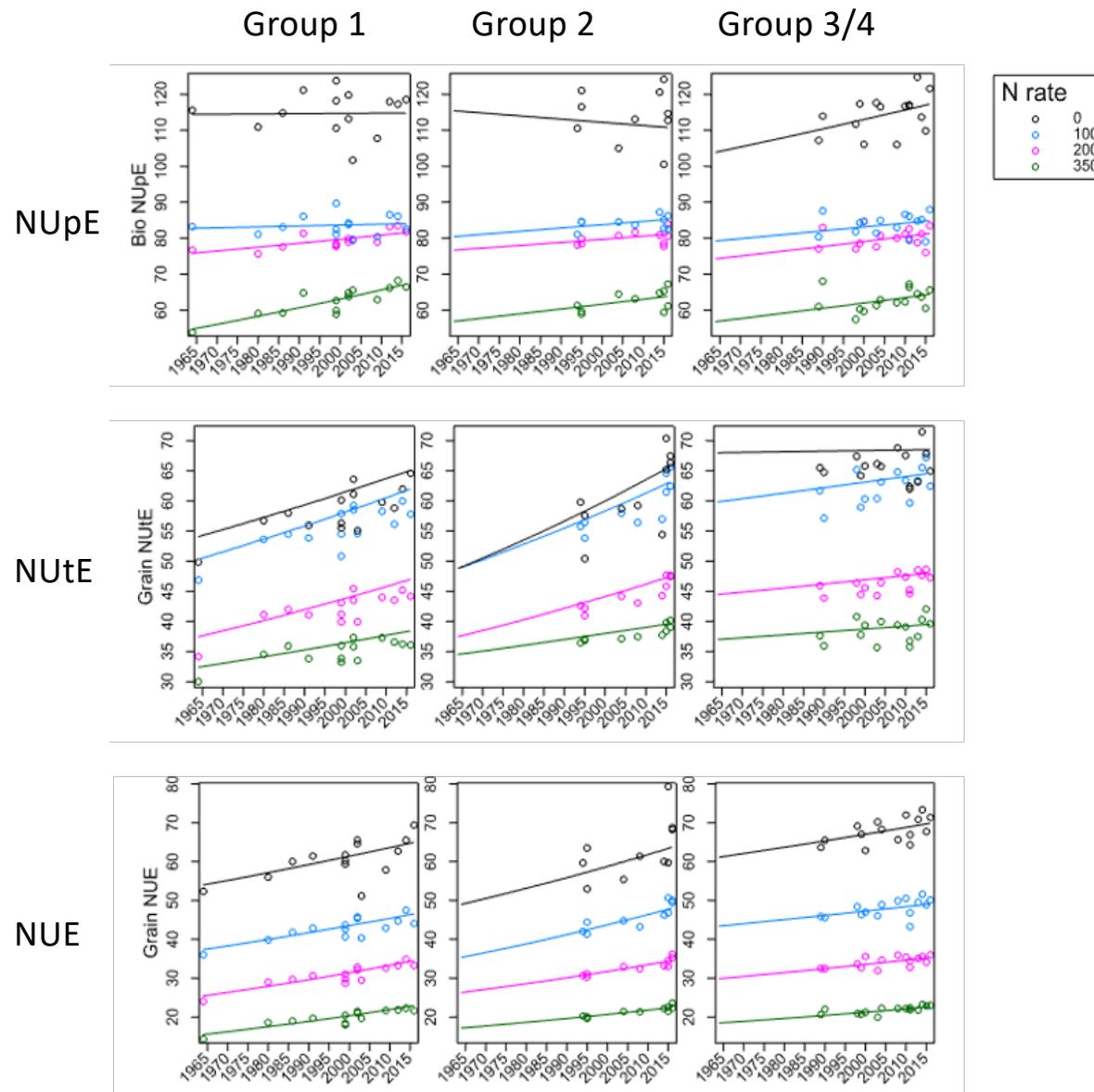
Have varieties improved over time?

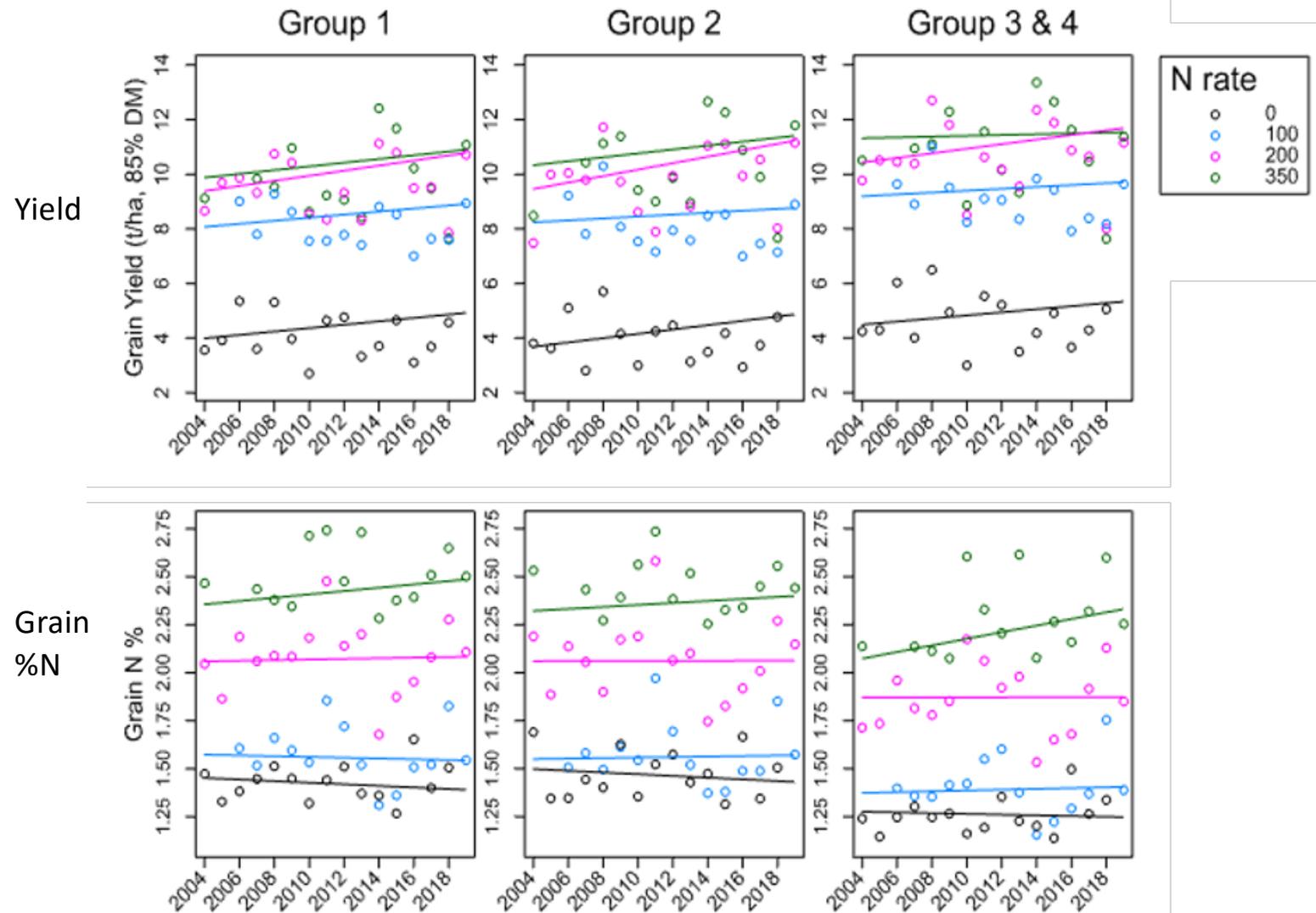Yield and grain N trends based on <u>year of release</u>
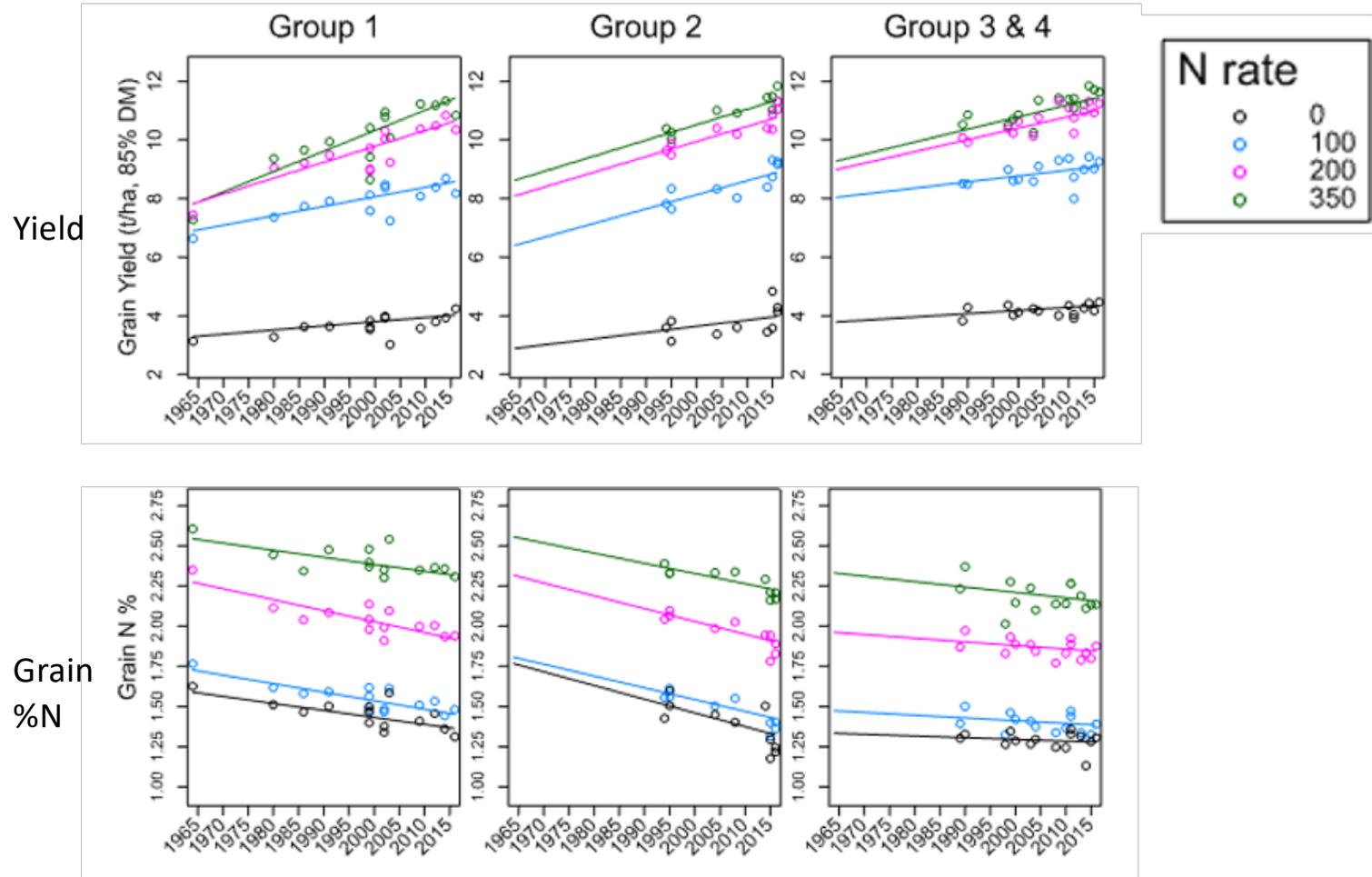
NUE trends based on year of release

- NUE increases in more modern varieties, for all nabim types and at all N-inputs

- Due to increases in both uptake efficiency and utilization efficiency
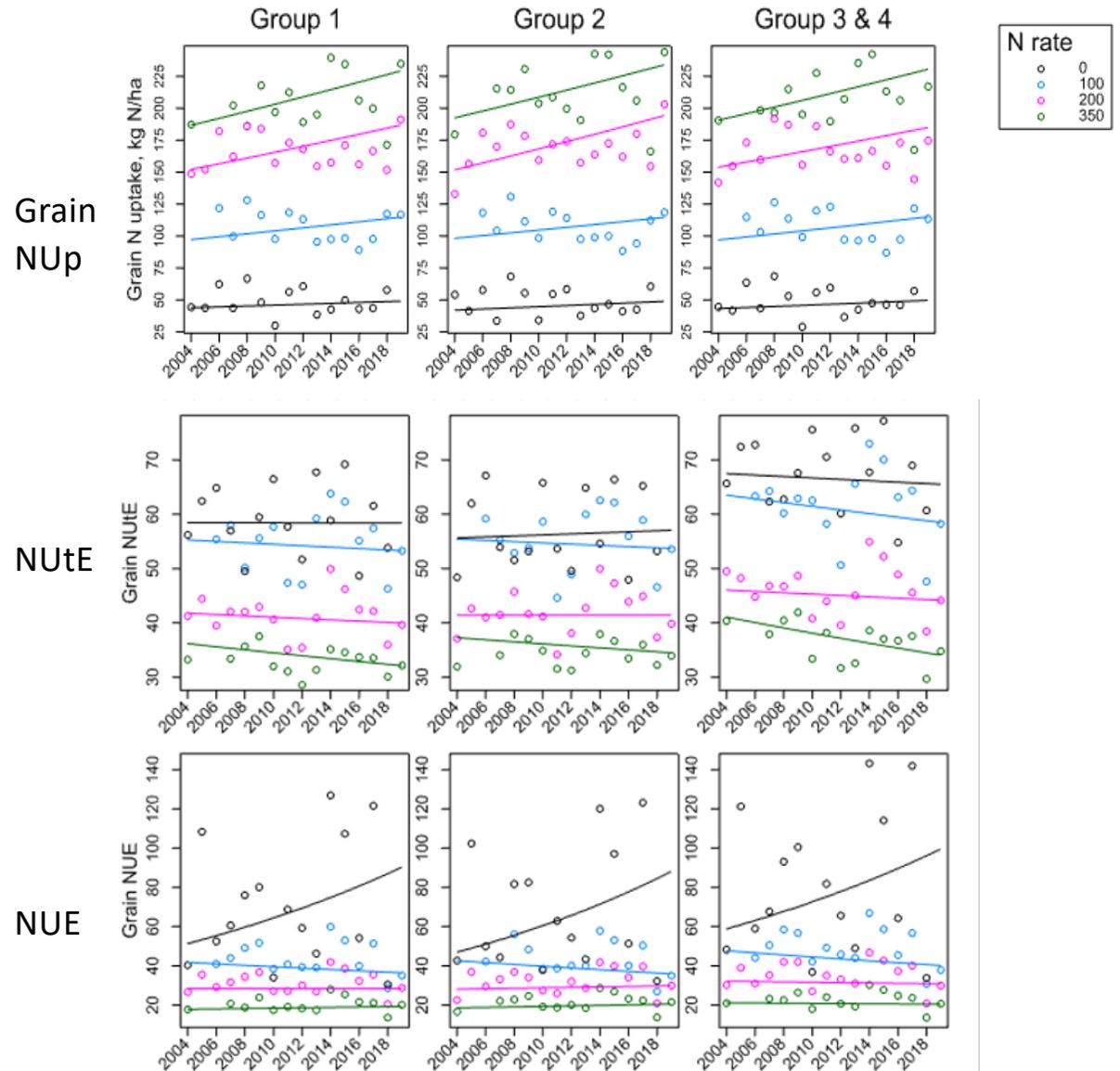
Are there trends over the time span of the project?

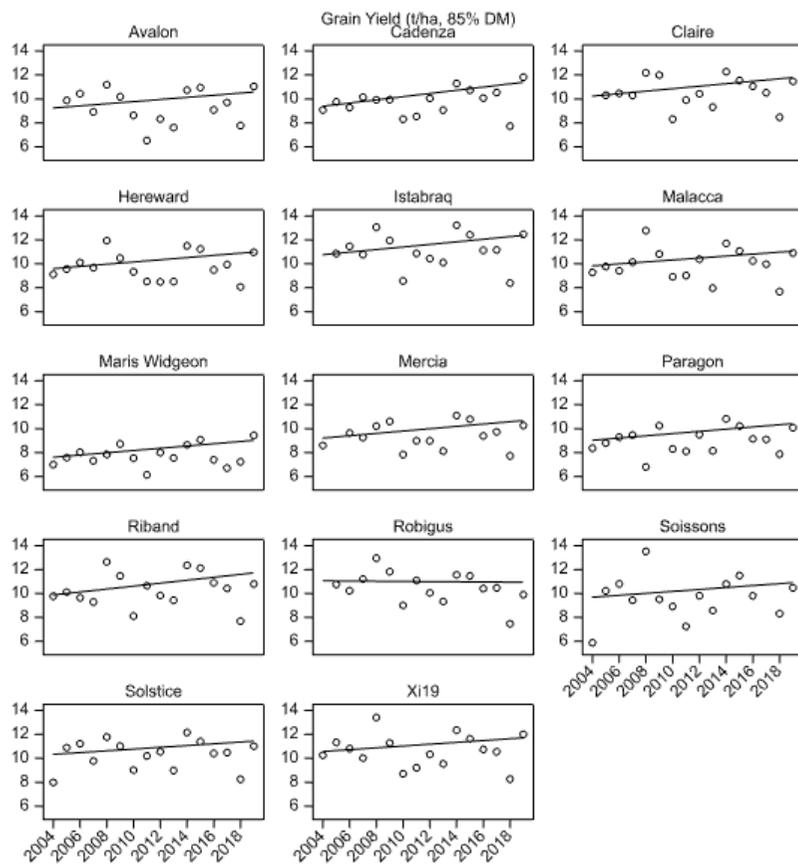Yield and grain protein trends based on <u>year of trial</u>

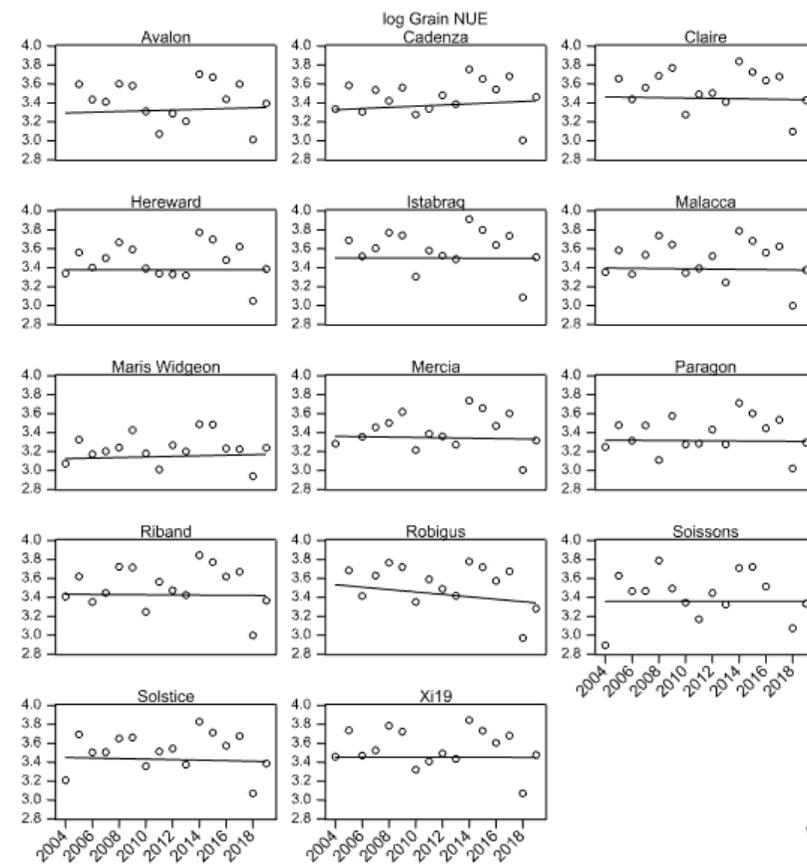# NUE trends based on <u>year of trial</u> for core varieties

Yield and NUE trends for <u>individual varieties</u> for year of trial
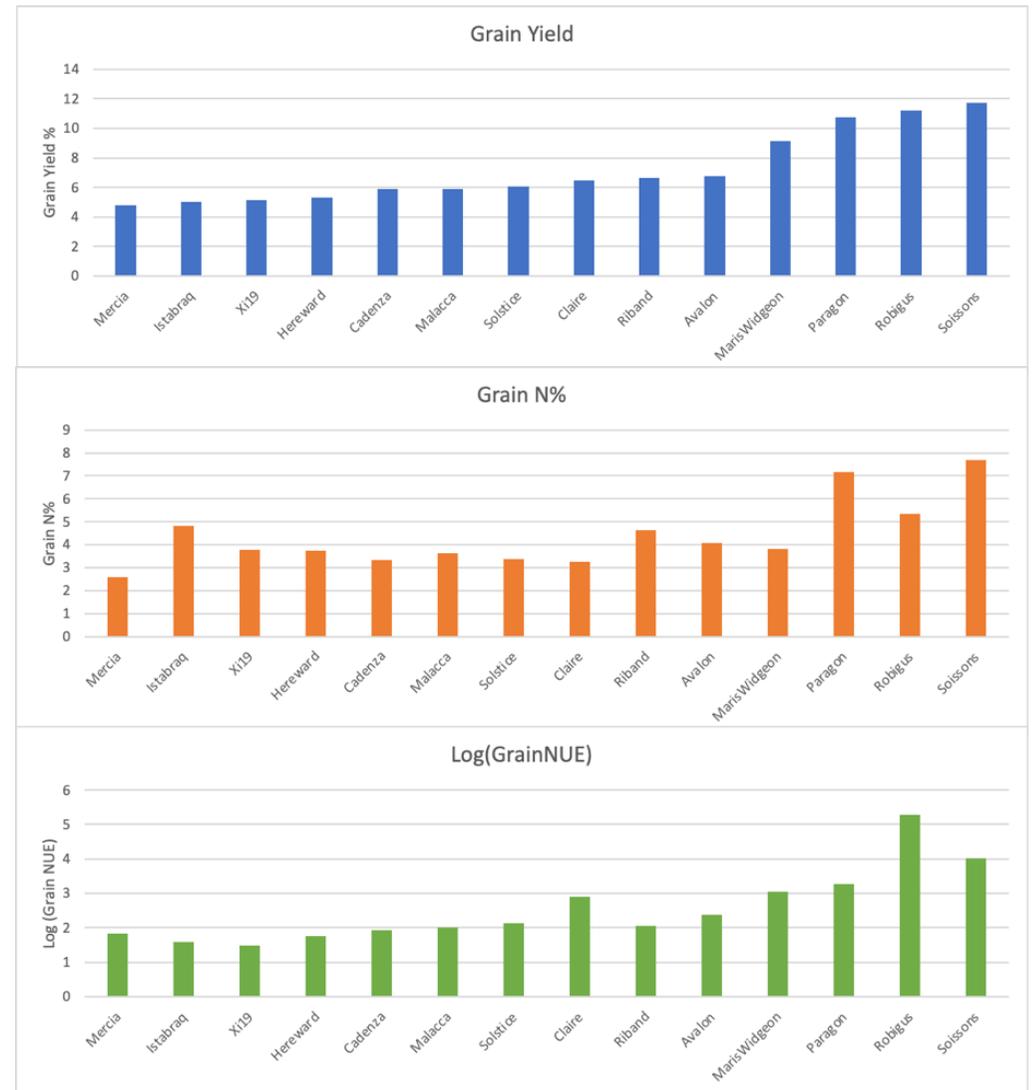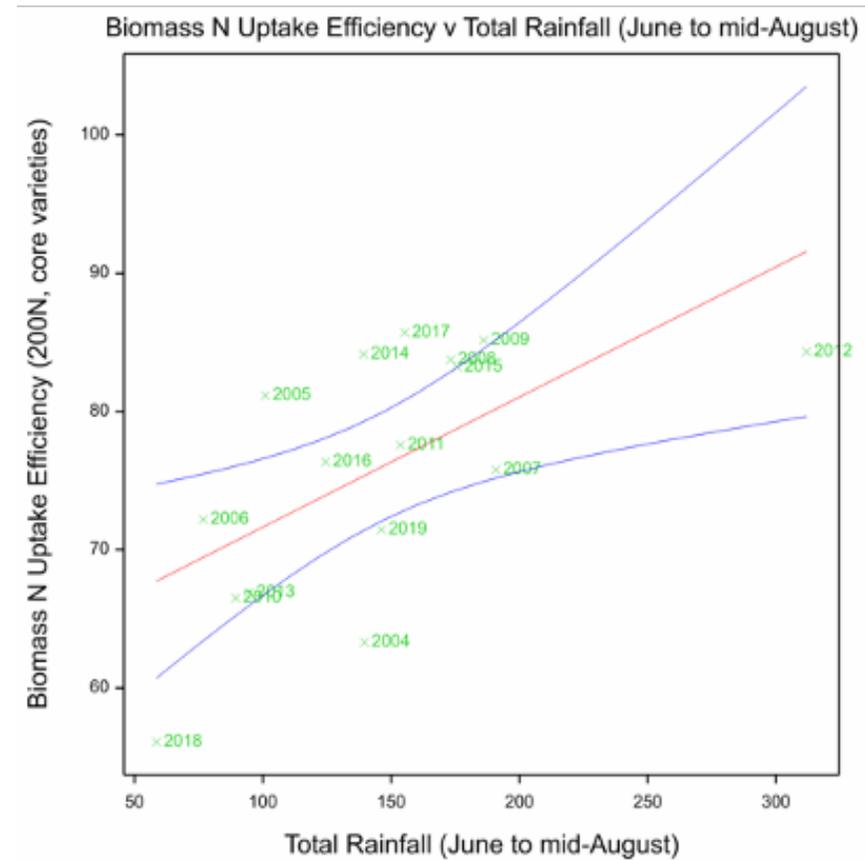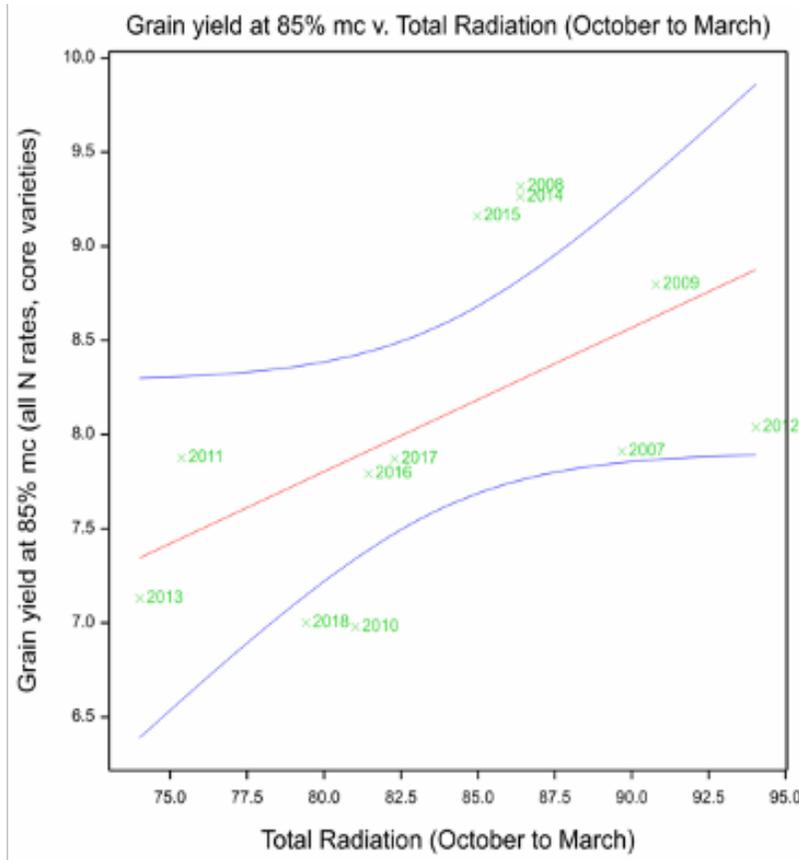
Grain yield

log Grain NUE

Assessment of trait stability over harvest years

- N200 data

- Core varieties

- Variety by year interaction effects

- Difference predicted means and expected means

- Smaller values indicate greater stability

Is performance (easily) aligned with the weather?
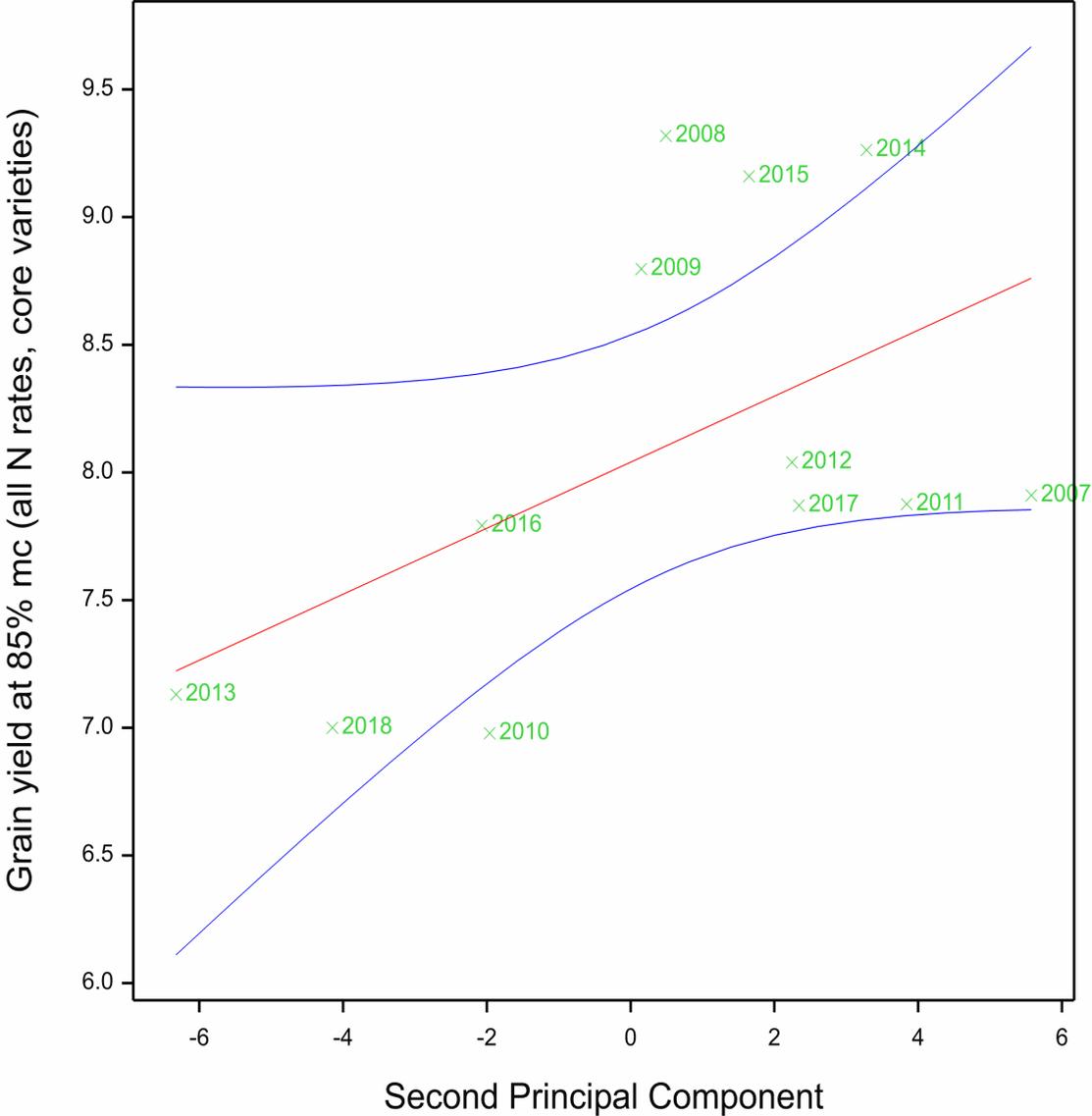## Examples of correlations with individual weather parameters

PCA plot of each harvest year using 12 weather variables

6 = daily rainfall June;
15 = daily radiation March;
18 = daily radiation June;
27 = daily GDD March;
28 = daily GDD April;
31 = daily GDD July;
32 = daily GDD August;
35 = daily GDD November;
39 = daily maximum temperature March;
40 = daily maximum temperature April;
43 = daily maximum temperature July;
47 = daily maximum temperature November
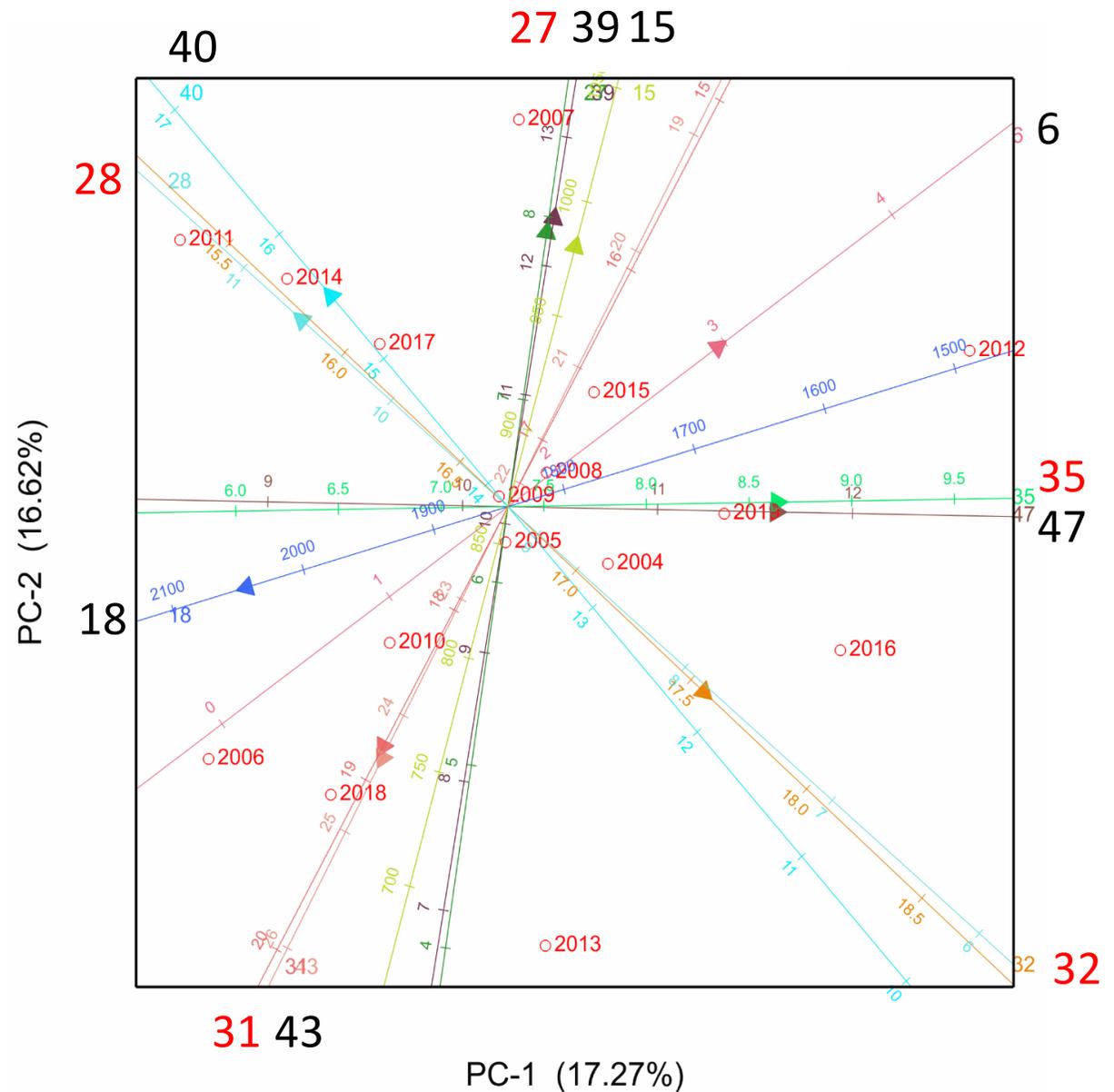
Correlation of multiple weather parameters (second principal component) with grain yield

Summary/conclusions

- Data available on WGIN website

- Report available from Defra

http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=19975&FromSearch=Y&Publisher=1&SearchText=CH0109&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description

- Trials are continuing with some modifications

- Many thanks to my co-authors, the Rothamsted teams involved, and particularly the Rothamsted farm staff

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