



Effects of high peaks vs high background ozone on wheat

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Introduction

- ❑ Comparing response to ozone supplied as peaks (local/regional pollution) and background (hemispheric pollution)
- ❑ 2 current varieties of wheat (breadmaking).
- ❑ Mulika (released 2011) and Skyfall (released 2014)



Methodology

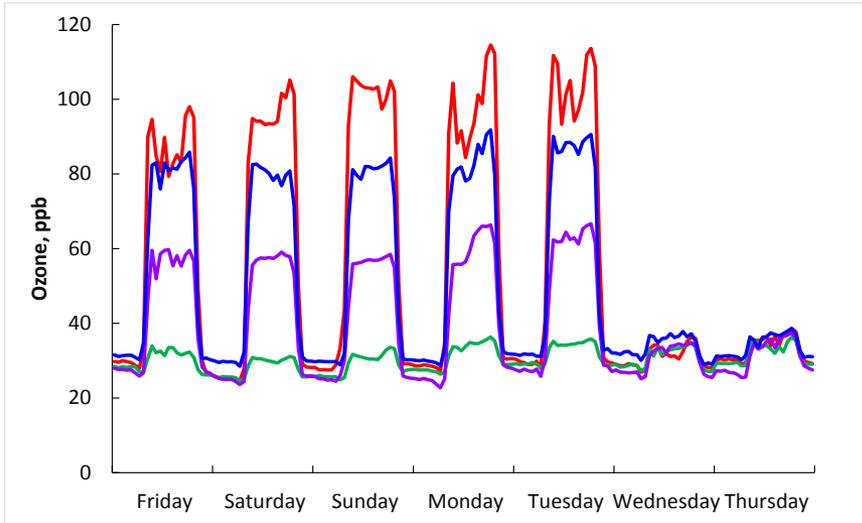
- Wheat seeds planted in loam-based compost mix, 25 litre containers
- Exposed to ozone in solardomes 15th May – 12th August 2015

Measurements made included:

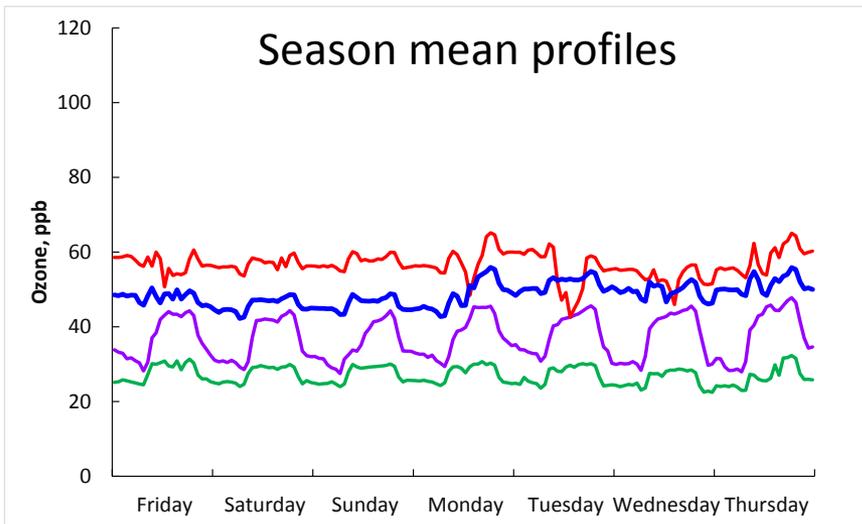
- Harvest index
 - Number of ears
 - Grain number per ear and 1000 grain weight
 - C and N content of grains and soil (in progress)
 - A_{Ci} curves of flag leaves
 - Chlorophyll content of flag leaves
 - A_{sat} of flag leaves
 - Stomatal conductance
-
- Drought experiment - Steph



High peaks vs high background treatments



8 ozone treatments applied in matching pairs with “same” seasonal mean but applied as peaks or background



O ₃ (24h mean)	background	peaks
Low	27.0	30.3
Medium	37.0	39.2
High	48.6	50.2
Very high	56.5	55.4

Results

Mulika

19th June 2015



Canopy height was the same

A little senescence high in the canopy

A lot of senescence low in the canopy

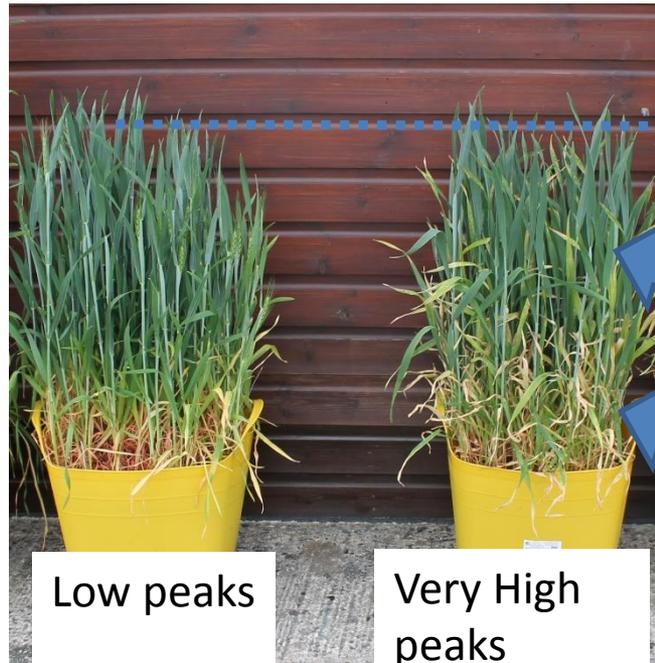
Low peaks

Very High peaks

Results

Skyfall

19th June 2015



Low peaks

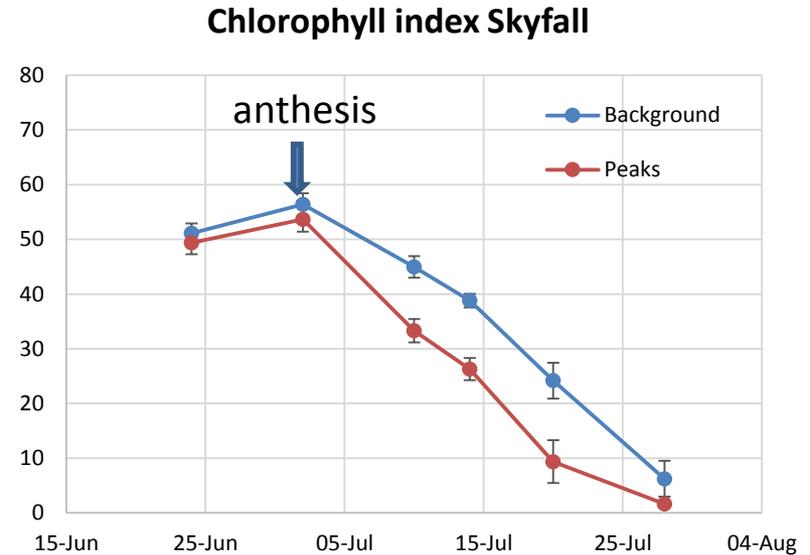
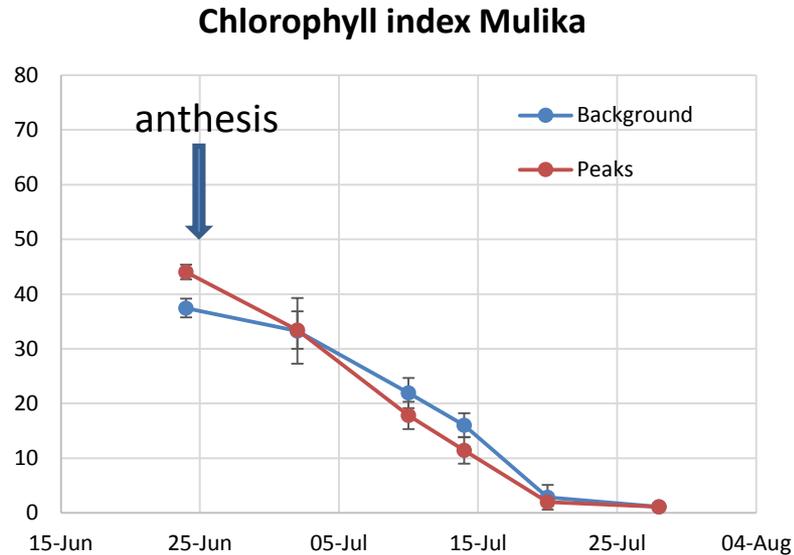
Very High
peaks

Canopy height was
the same

Some senescence
high in the canopy

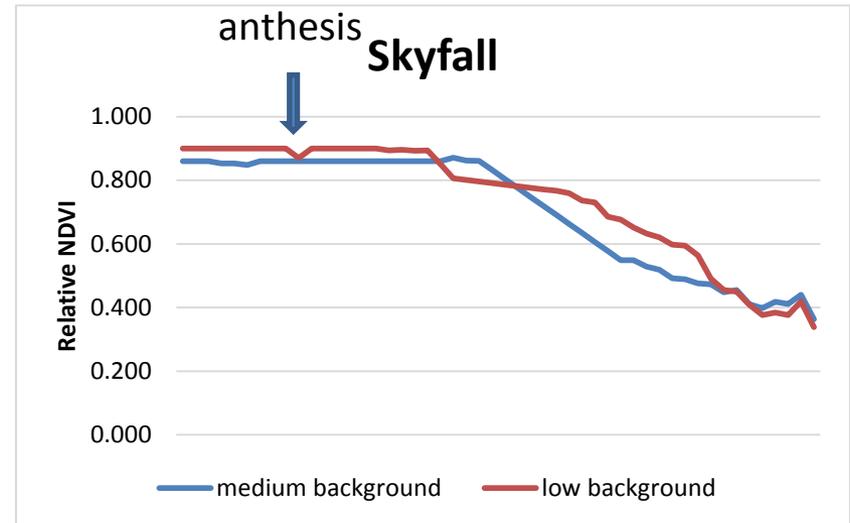
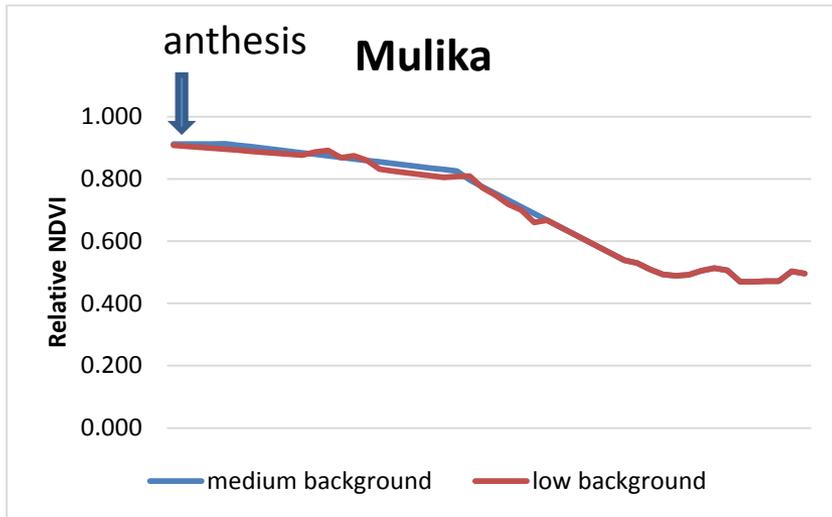
A lot of senescence
low in the canopy

Accelerated senescence shown in chlorophyll index data



- ❑ For Mulika the decline in chlorophyll content was similar in the high background and high peaks ozone treatments
- ❑ For Skyfall the decline in chlorophyll content was faster with high peaks

Accelerated senescence shown in canopy NDVI data

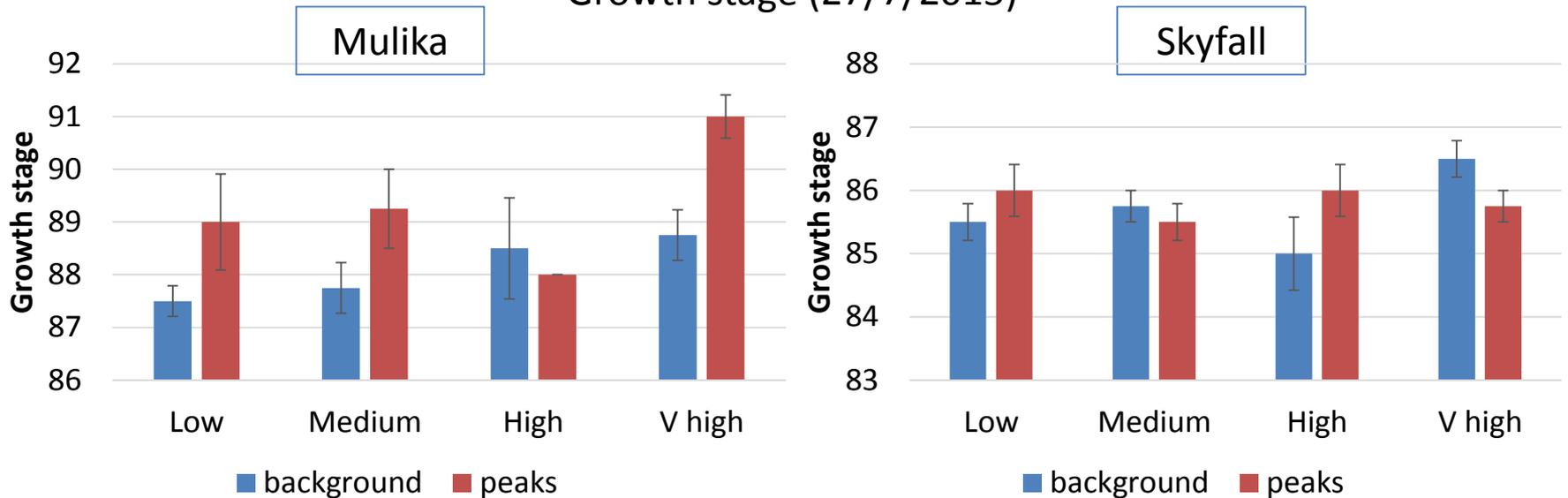


- ❑ Continuously logging NDVI sensors detected small differences in canopy greenness
- ❑ Differences are not as pronounced as single leaf chlorophyll measurements
- ❑ Ears and stems are also included in the measurement



Growth stage

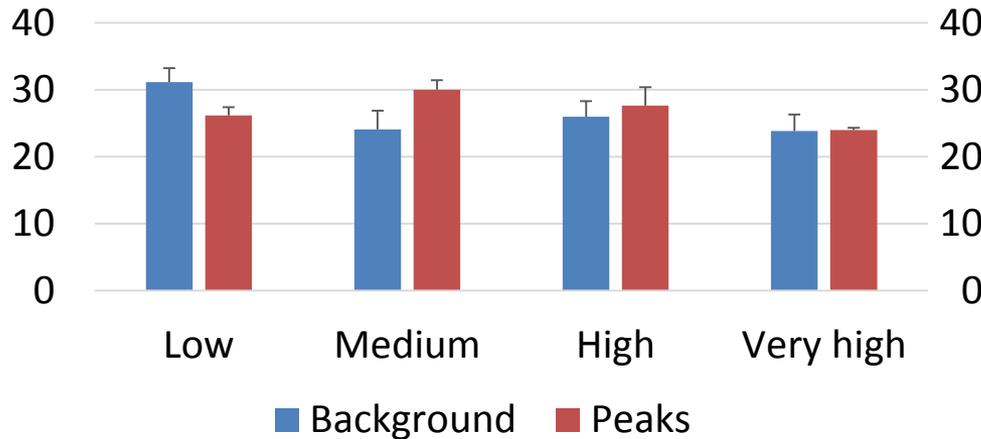
Growth stage (27/7/2015)



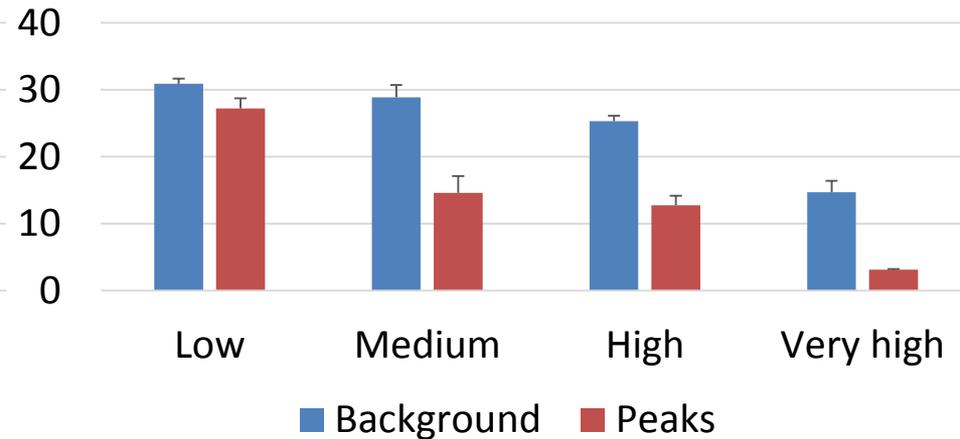
- ❑ There was no evidence that development of Skyfall was accelerated by ozone. (growth stage the same across all treatments).
- ❑ A hint that development might have been accelerated very slightly in Mulika.
- ❑ (development of Mulika was faster than for Skyfall).

A_{sat} (Skyfall)

Asat (23/24 June 2015)



Asat (14 July 2015)

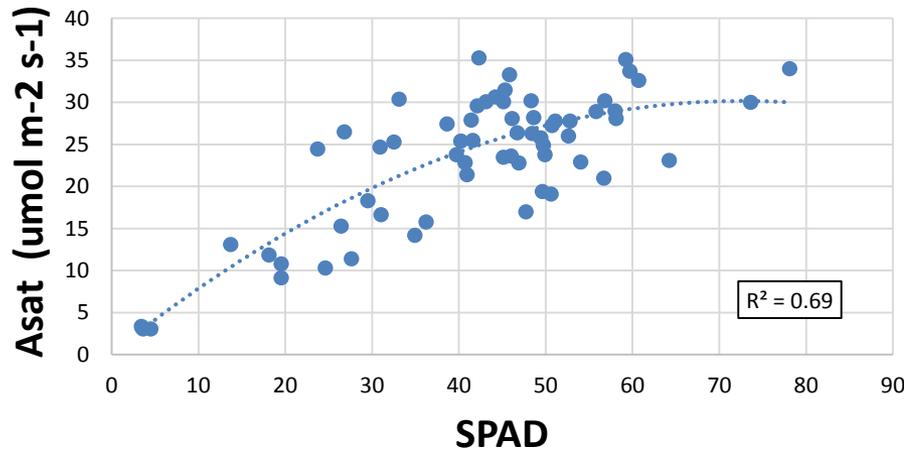


- ❑ A_{sat} was similar across all ozone treatments before anthesis.
- ❑ There was a decrease in A_{sat} with increasing ozone after anthesis
- ❑ The decline was much faster with the 'peaks' treatments.

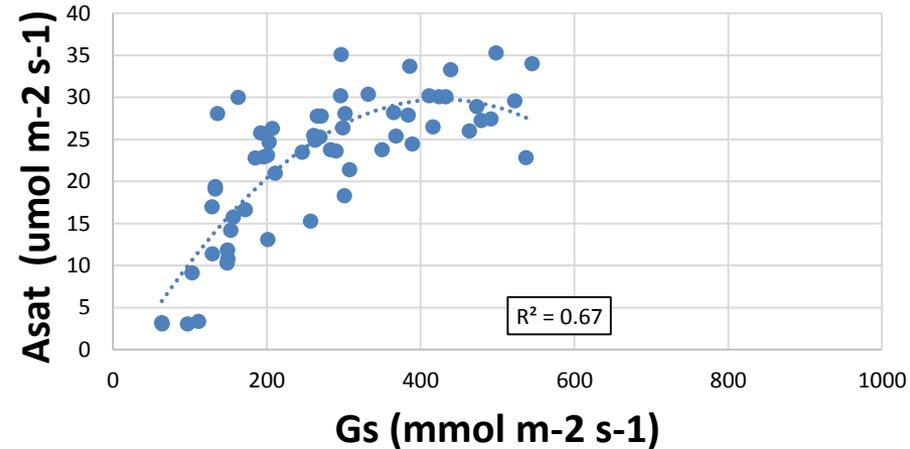
Anthesis 1st July

A_{sat} related to chlorophyll content

June & July 2015 (polynomial function)

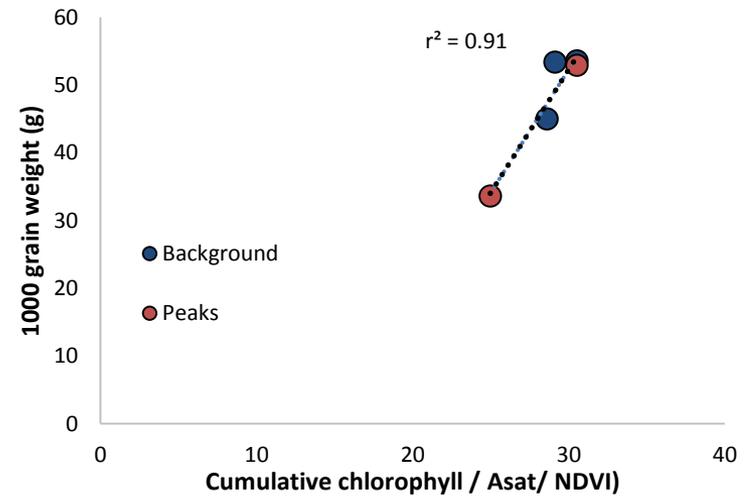
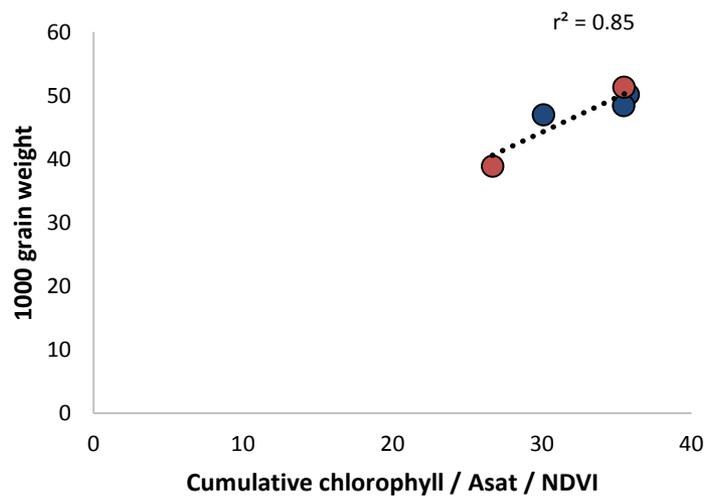
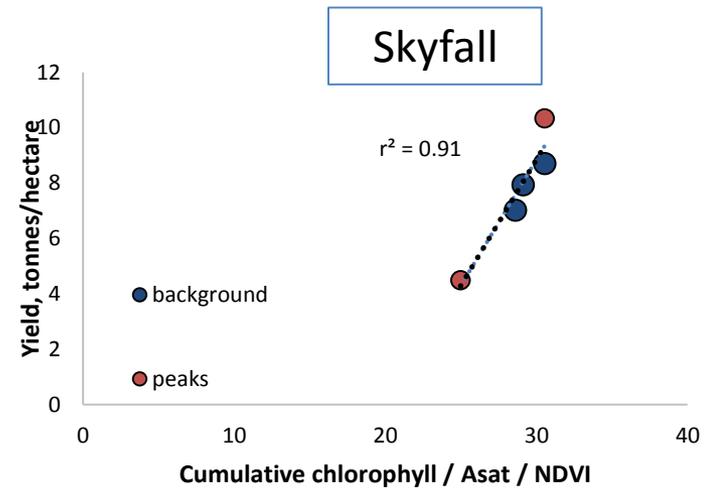
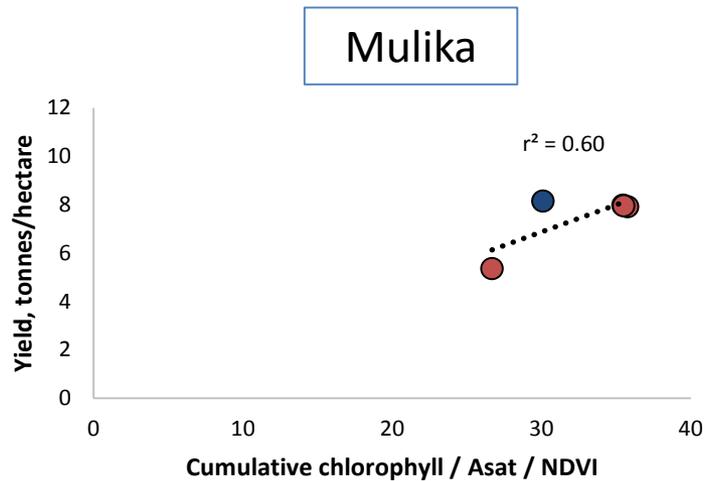


June & July 2015 (polynomial function - high G_s)



- A_{sat} was related to chlorophyll content.
- On individual days the relationship between A_{sat} and G_s was good, and still fairly good when all data was combined.

Yield related to chlorophyll (cumulative photosynthesis)

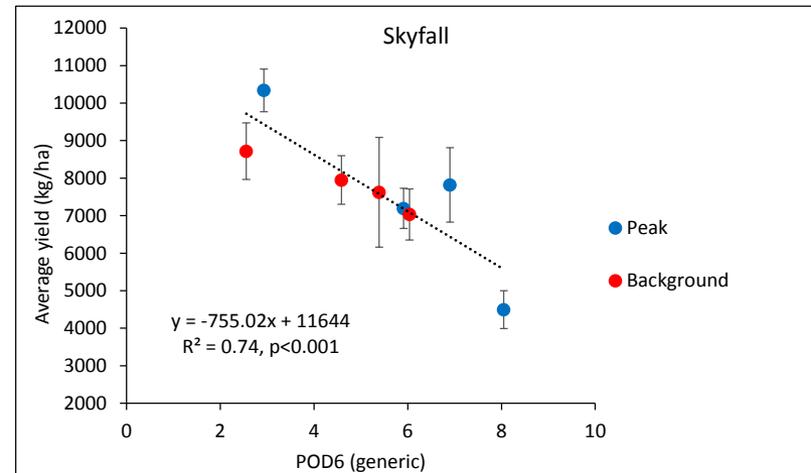
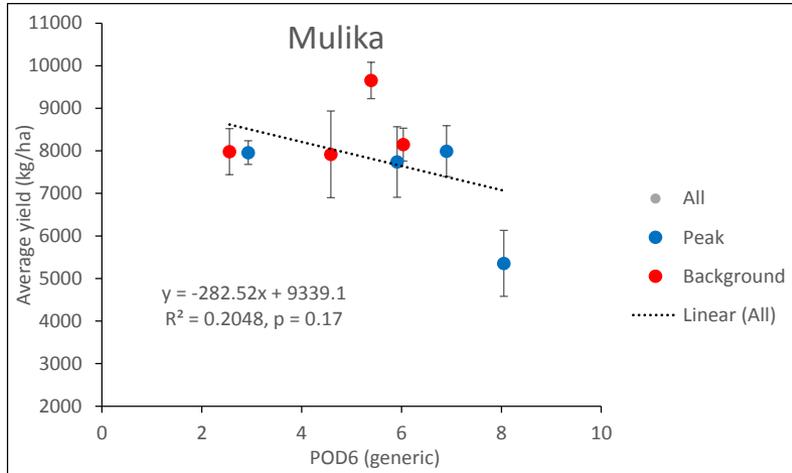


Wheat: Provisional flux-effect relationships using the standard wheat model, SWP not included but plants kept well-watered

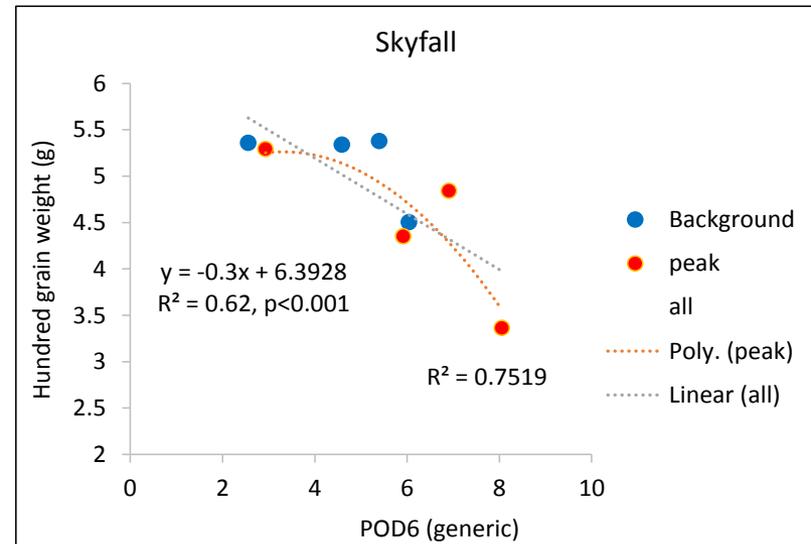
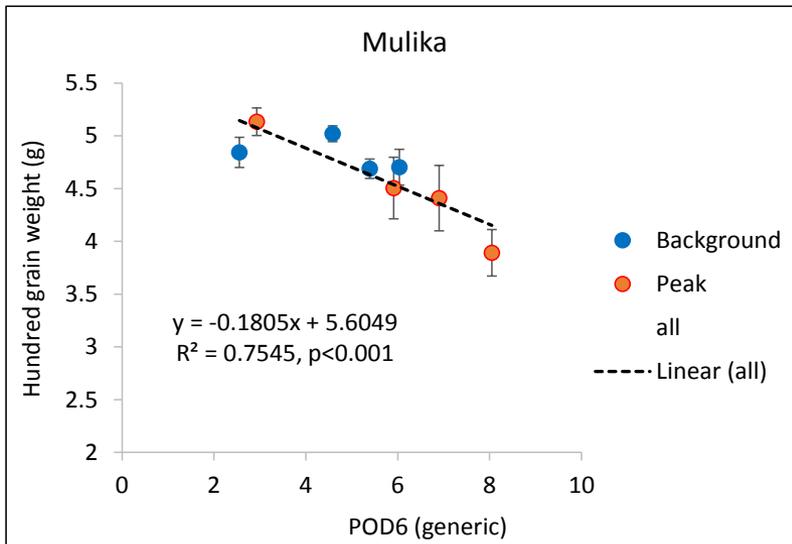
Mulika

Skyfall

Yield

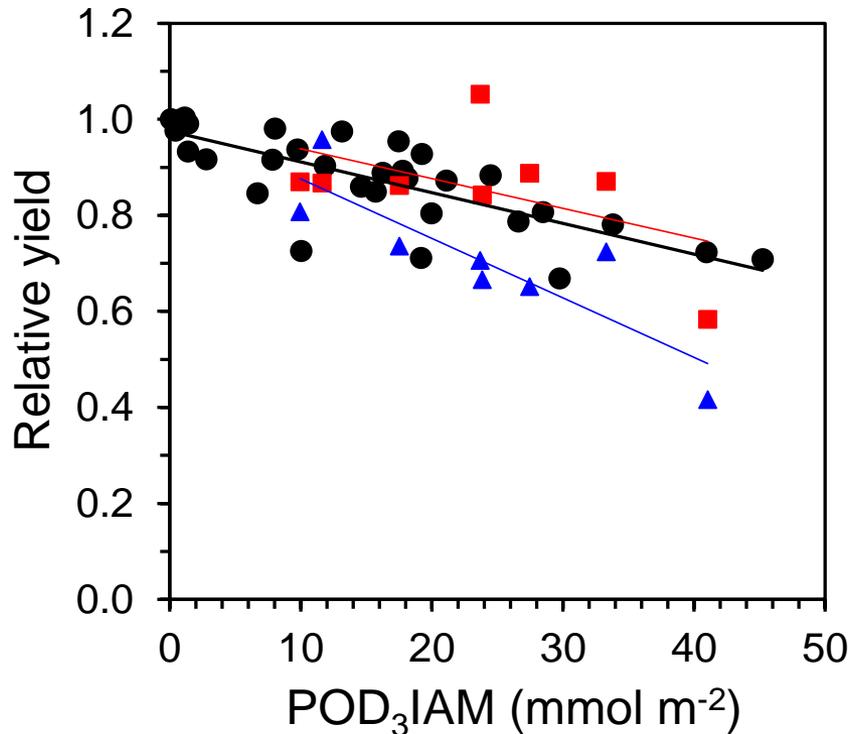


100 grain weight



MM POD₃IAM function, with new data added

For integrated assessment
modelling across Europe



$$y = 0.98 - 0.0064 * \text{POD}_3\text{IAM}$$
$$r^2 = 0.62, p < 0.0001$$

- MM data
- Mulika
- ▲ Skyfall
- Linear (MM data)
- Linear (Mulika)
- Linear (Skyfall)

Summary

- ❑ Senescence was accelerated by ozone. In Mulika the rate of senescence was the same when ozone was applied as either higher peaks or higher background.
- ❑ There was no evidence that the rate of development was affected.
- ❑ After anthesis, A_{sat} was decreased with increasing ozone treatment and this was related to the changes in senescence (chlorophyll content). For Skyfall, the decline was faster in the 'peaks' treatments.
- ❑ Yield and 100 grain weight were both decreased with increasing ozone. The apparent differences between 'peaks' and 'background' responses were explained by ozone flux (ozone fluxes were higher in the 'peaks' treatments as ozone was present in conditions favourable to uptake).
- ❑ **This study provides evidence that the flux based dose-relationships developed using experiments with episodic ozone exposure are also applicable for predictions of yield responses with increasing background ozone concentrations.**