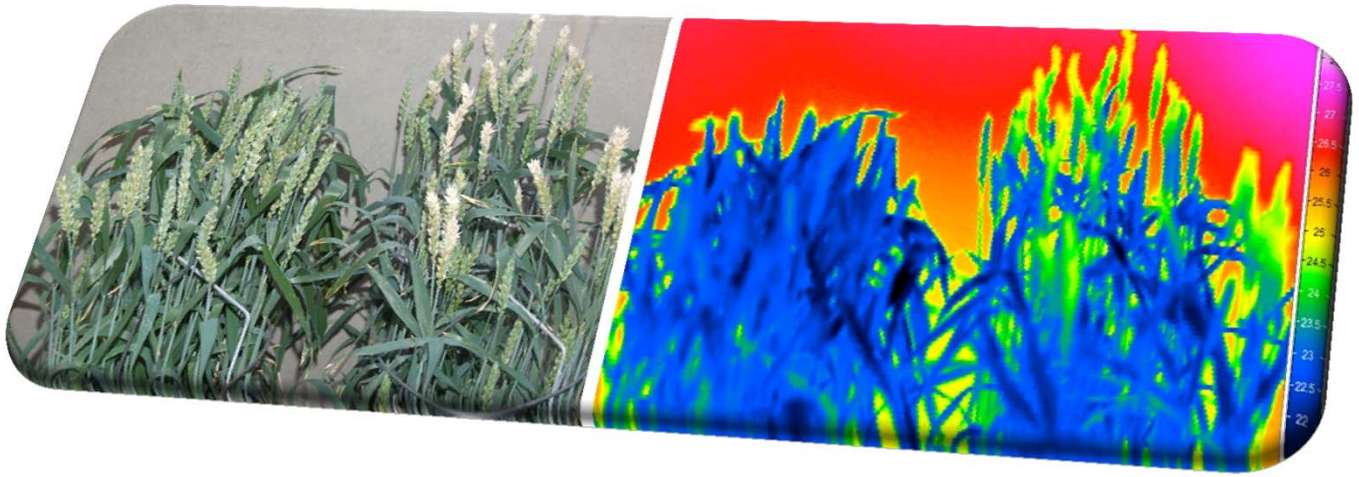
Influence of fungicides on wheat physiology measured by different sensors and imaging techniques

Carlos A. Berdugo, A.-K. Mahlein, U. Steiner, E.-C. Oerke and H.-W. Dehne



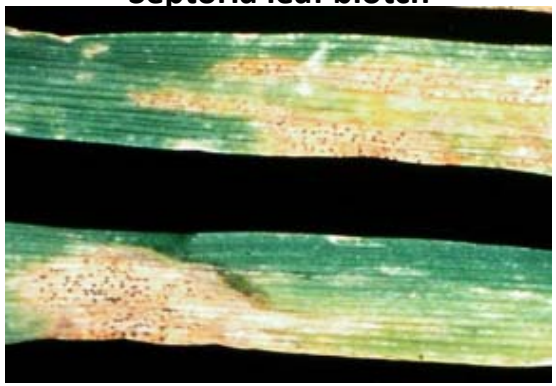
Landwirtschaftliche
Fakultät der
Universität Bonn

universitätbonn

Use of fungicides

1. Disease control

Septoria leaf blotch



Leaf rust

Powdery mildew

2. Positive side effects

- Plant metabolism
- Green leaf area duration
- Tolerance against abiotic stress

Use of fungicides

Evidences of side effects

Triazoles:

Induced morphological changes, e.g.:
- reduction in shoot elongation
- stimulation of rooting
- smaller and thicker leaves

→
- inhibit gibberellin biosynthesis
- increased cytokinin synthesis
- transient rise in ABA

Strobilurins:

Delay of leaf senescence and prolonged photosynthetic activity of green tissue

→
- reduction of ACC synthase activity
- inhibit the ethylene biosynthesis

Beneficial effects

Different parameters have been measured to quantify side effects of fungicides:

- Enzymatic activity
- Balance of phytohormones
- Chlorophyll content

} *Destructive methods*

- Assessment of the percentage green leaf area

} *Subjective estimation*
May vary among individuals
Differences often have to be obvious

An excellent alternative is the use of sensors and imaging techniques

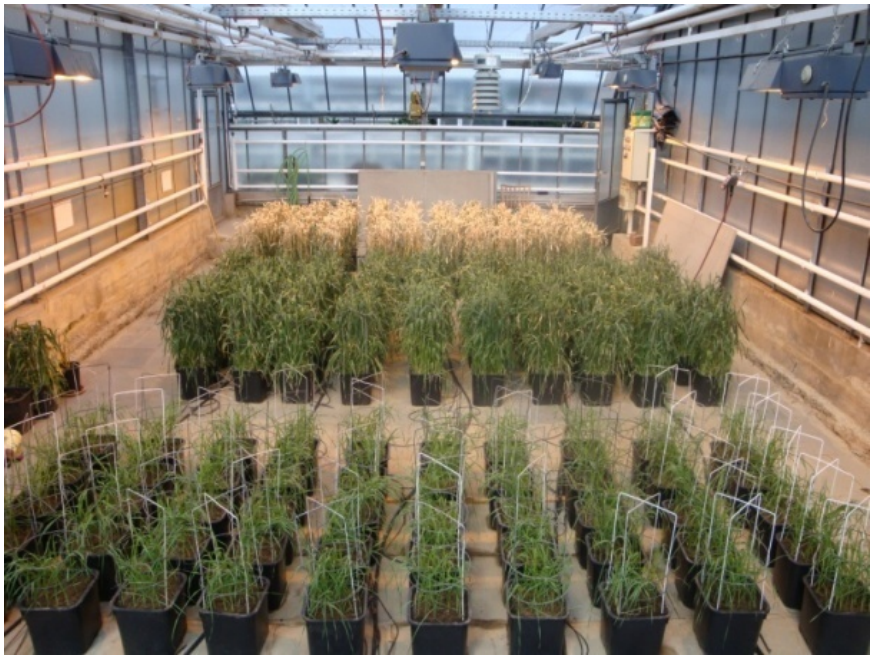
Scope of the study

Objectives

- Use of non-invasive and imaging techniques in order to assess effects of fungicides on crop plants
- Compare the effects of different fungicidal groups on wheat physiology and yield

The study involved

– Glasshouse experiments



Glasshouse experiments

Treatments:

Untreated control
Bixafen
Fluoxastrobin
Prothioconazole

GS 39: Flag leaf fully enrolled, ligule just visible

GS 59: Inflorescence fully emerged

GS 39+59

Parameters assessed:

- Green leaf area duration (GLAD) — **Visual assessment**
- Photosynthetic activity — **Chlorophyll fluorescence**
- Temperature of plant surface — **Infrared thermography**
- Leaf reflectance — **Spectral reflectance**

Non-invasive techniques

❑ Chlorophyll fluorescence

Portable chlorophyll fluorometer PAM-2000

❑ IR – Thermography

Varioscan 3021 ST

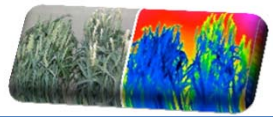
❑ Spectral reflectance

Spectroradiometer *ASD-FieldSpec*

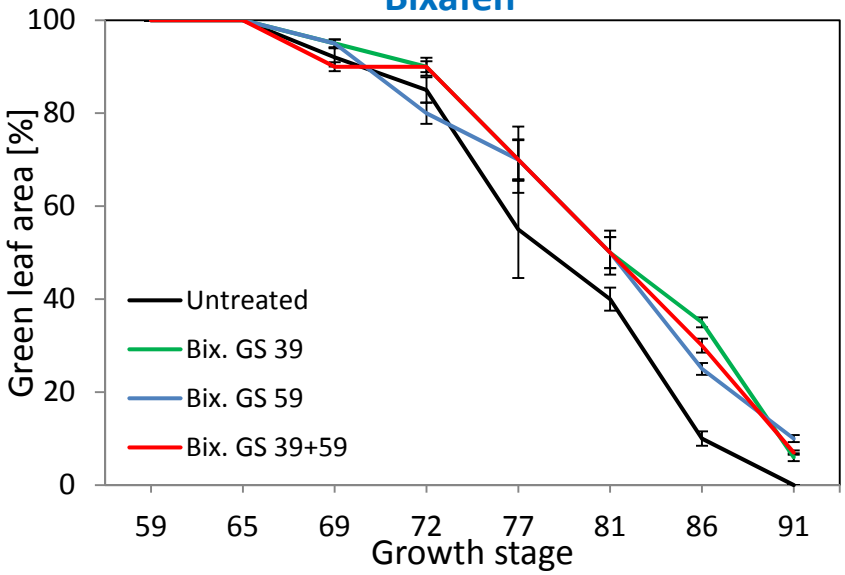
Spectral vegetation indices (SVIs)

Index	Equation	Associated to	Reference
Normalized difference vegetation index (NDVI)	**NDVI** = (R800 - R670)/(R800 + R670)	Plant vitality	Rouse et al. (1974)
Water index (WI)	**WI** = R900 / R970	Water content	Penuelas et al. (1997)

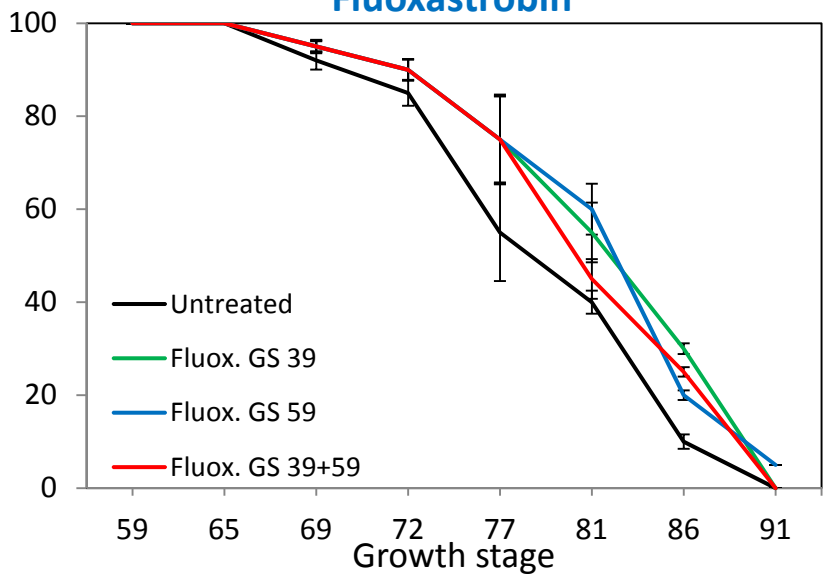
Green leaf area



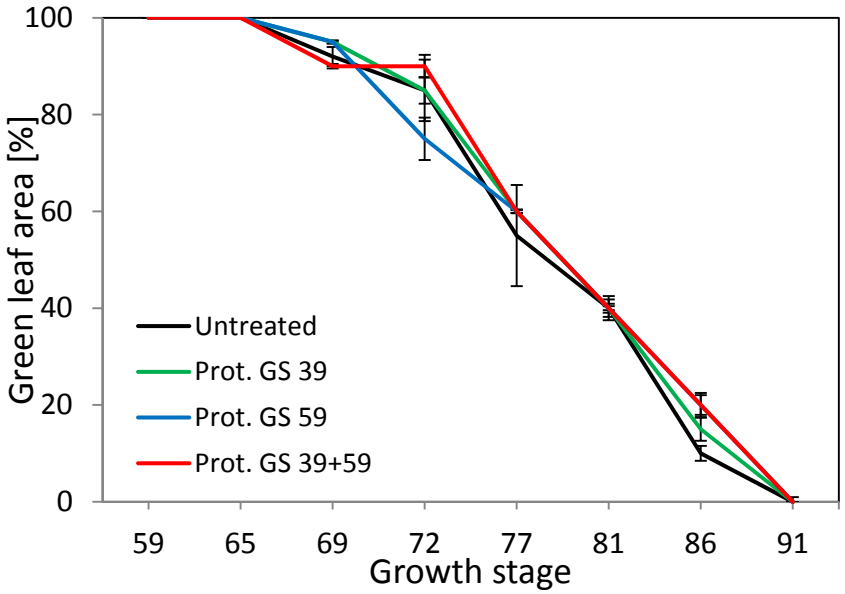
Bixafen



Fluoxastrobin

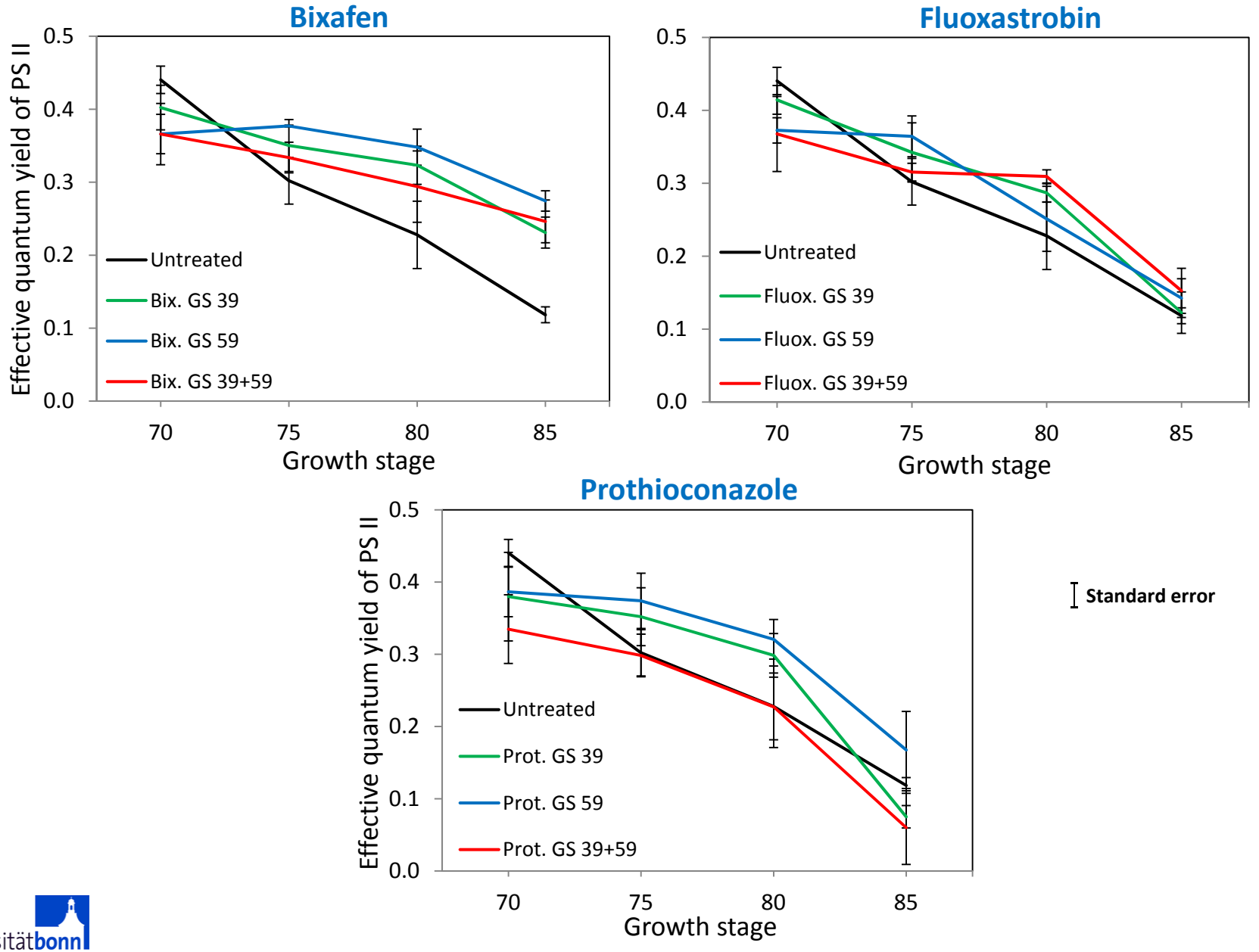


Prothioconazole

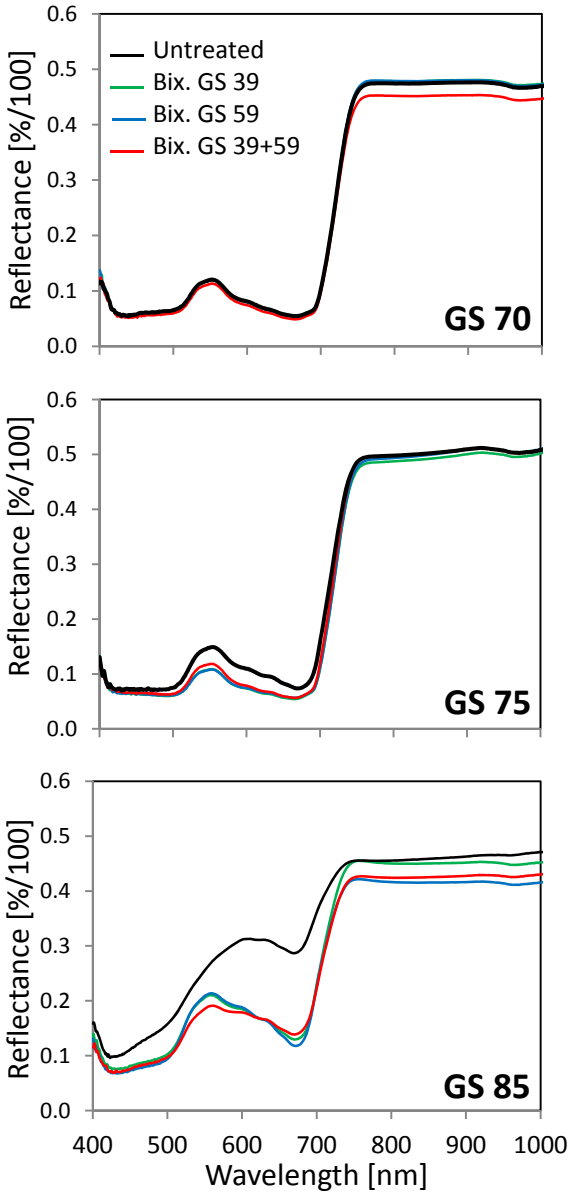


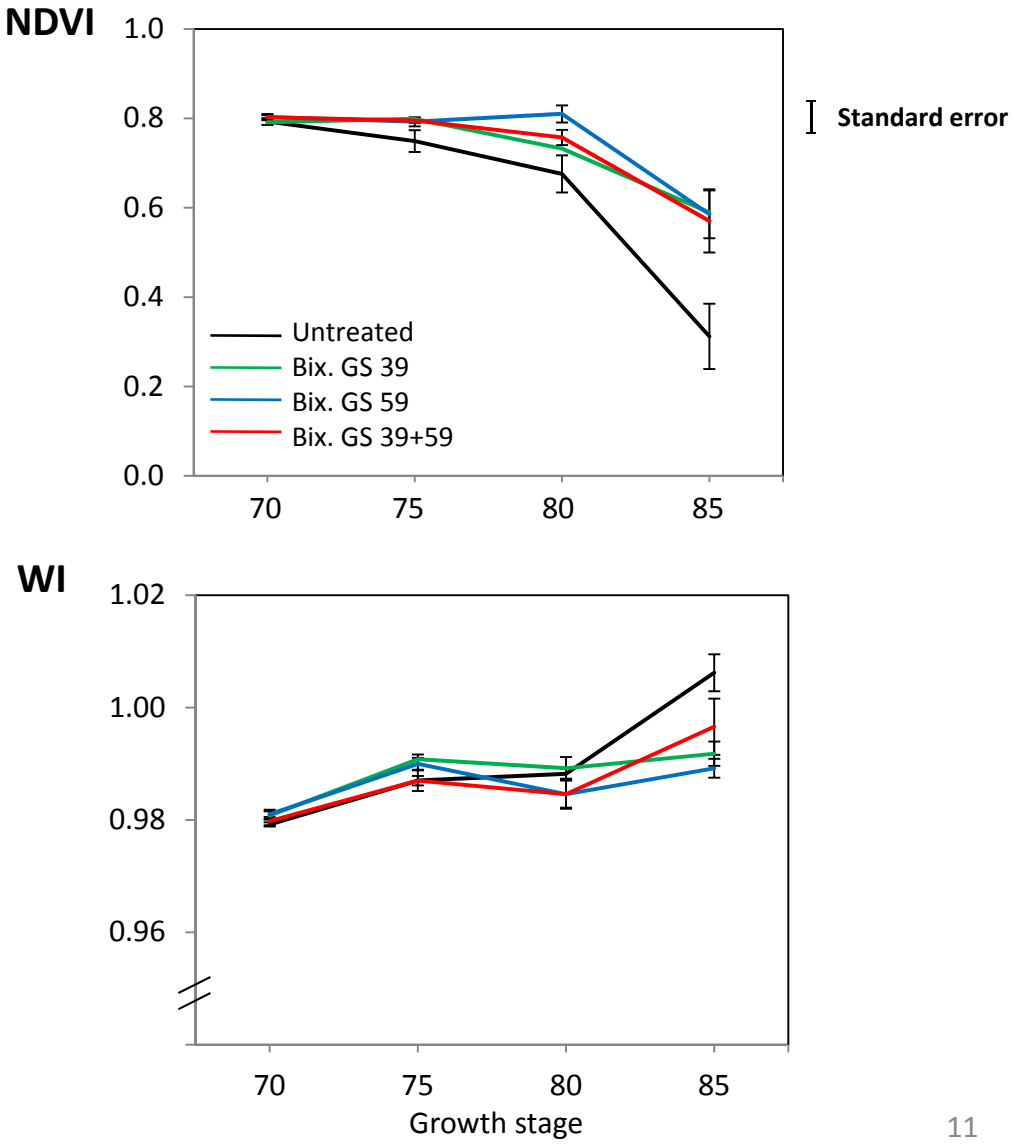
Standard error

Chlorophyll fluorescence of flag leaves

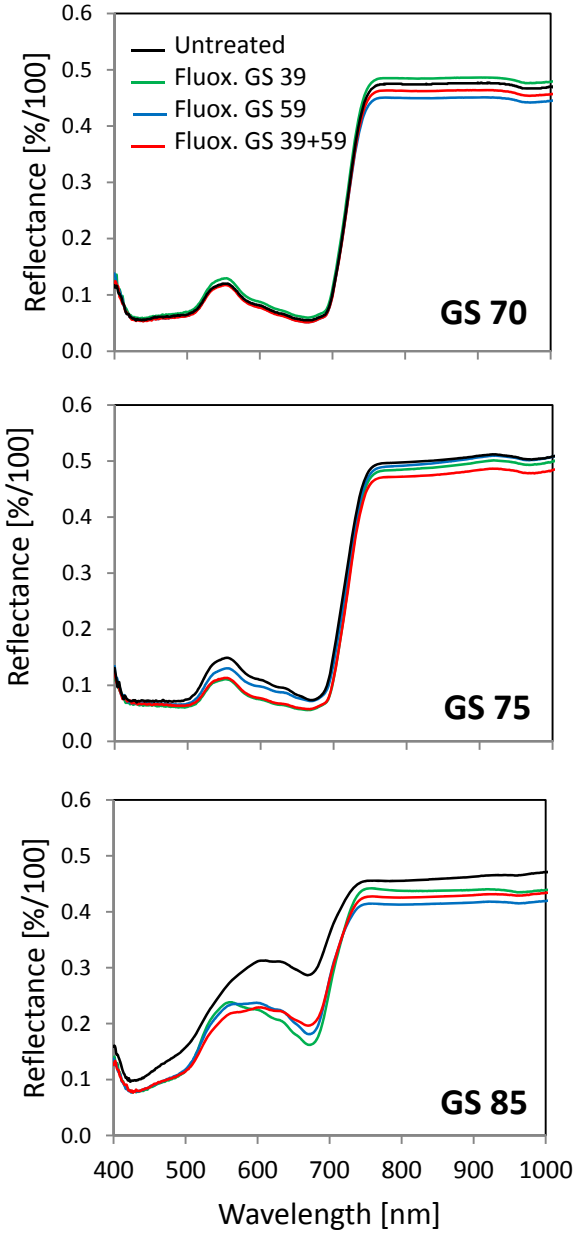


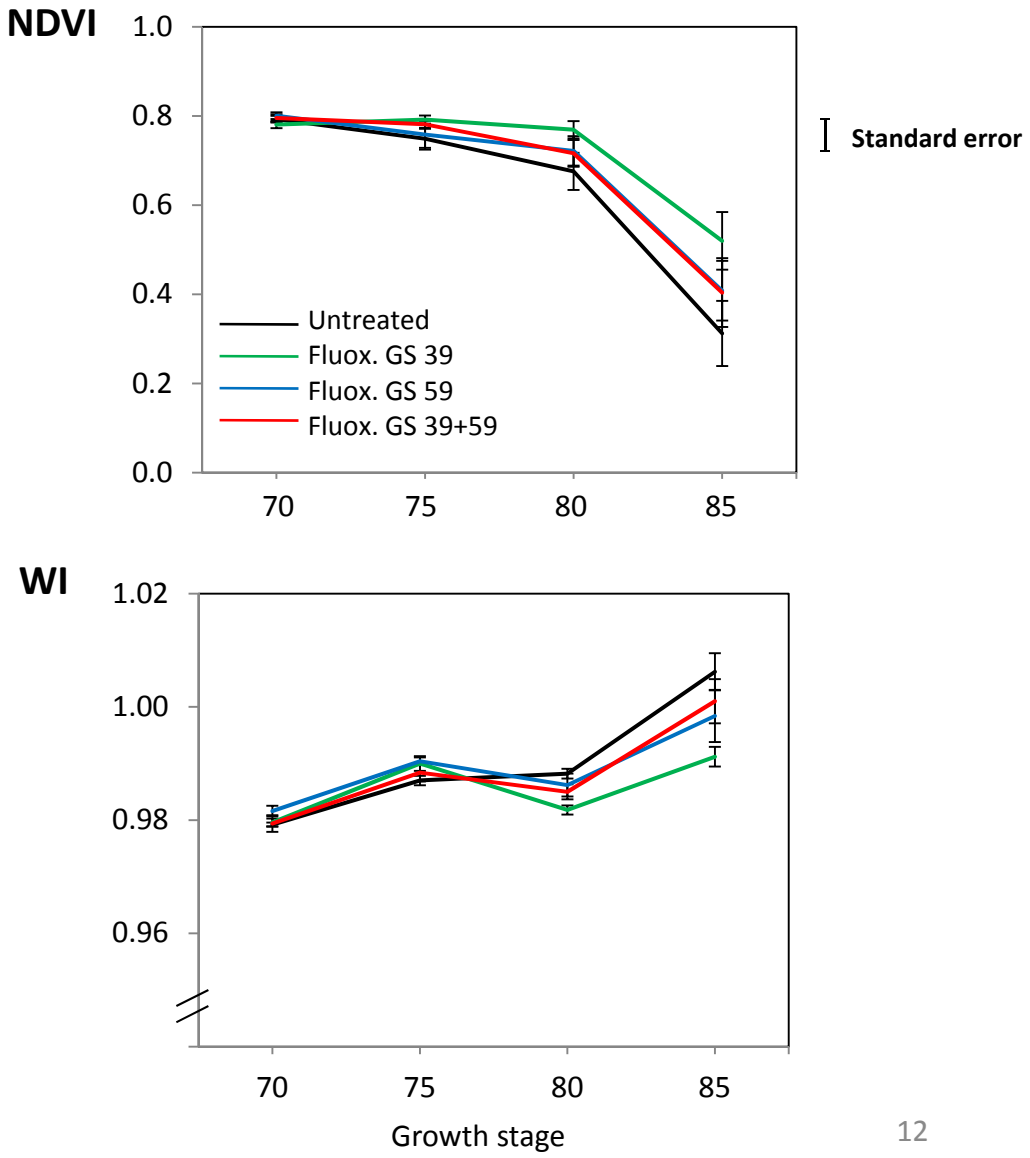
Leaf reflectance – Bixafen treatments



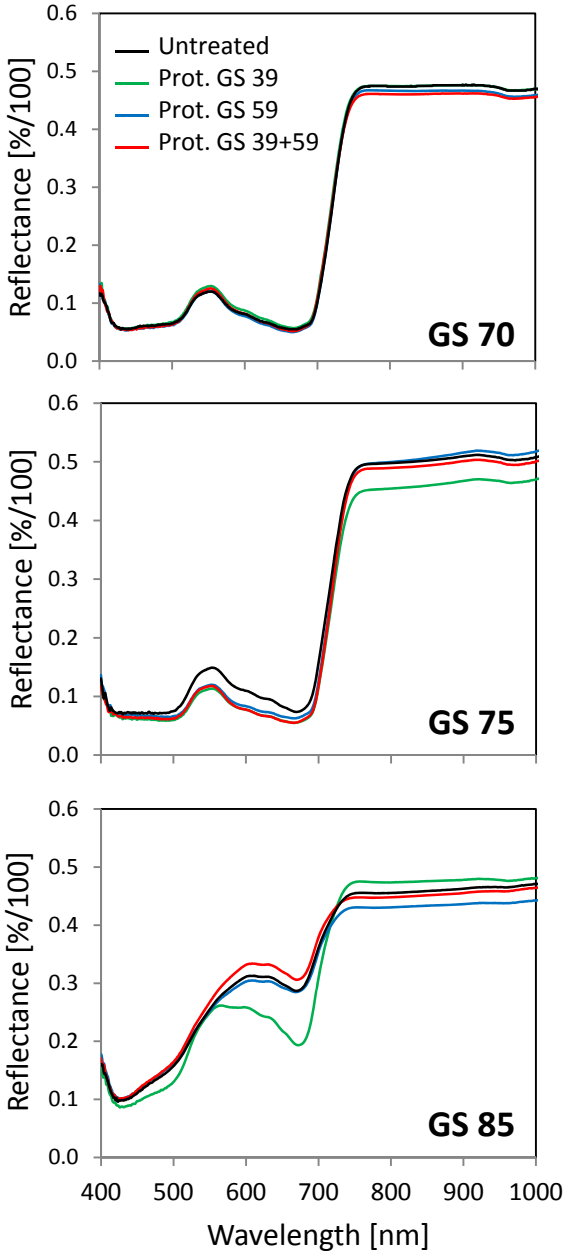


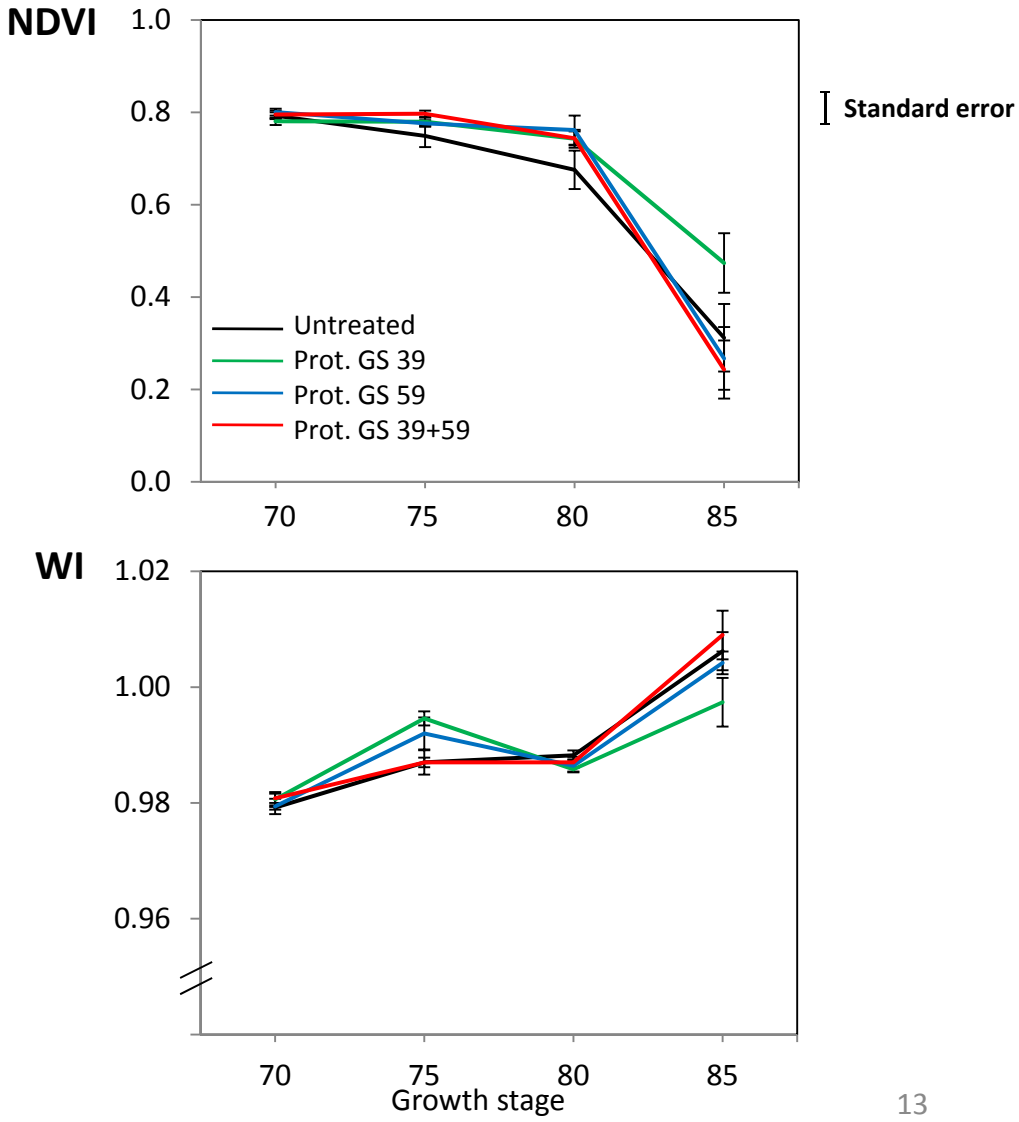
Leaf reflectance – Fluoxastrobin treatments



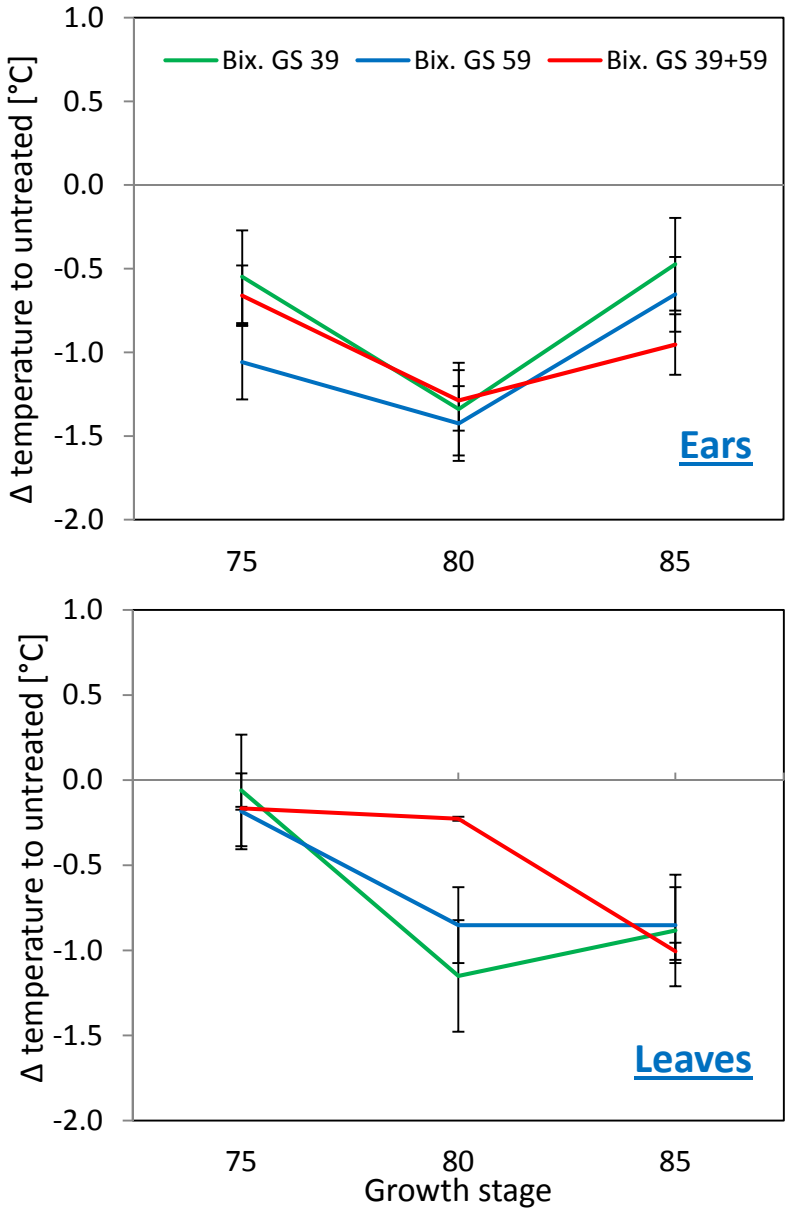


Leaf reflectance – Prothioconazole treatments

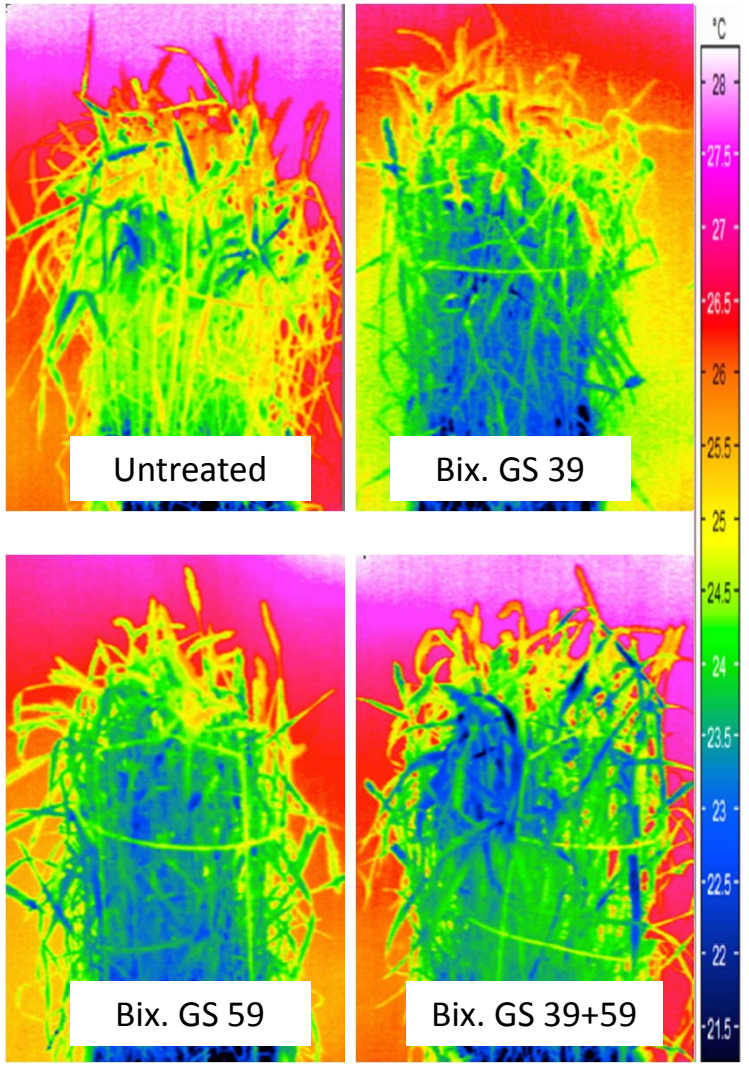




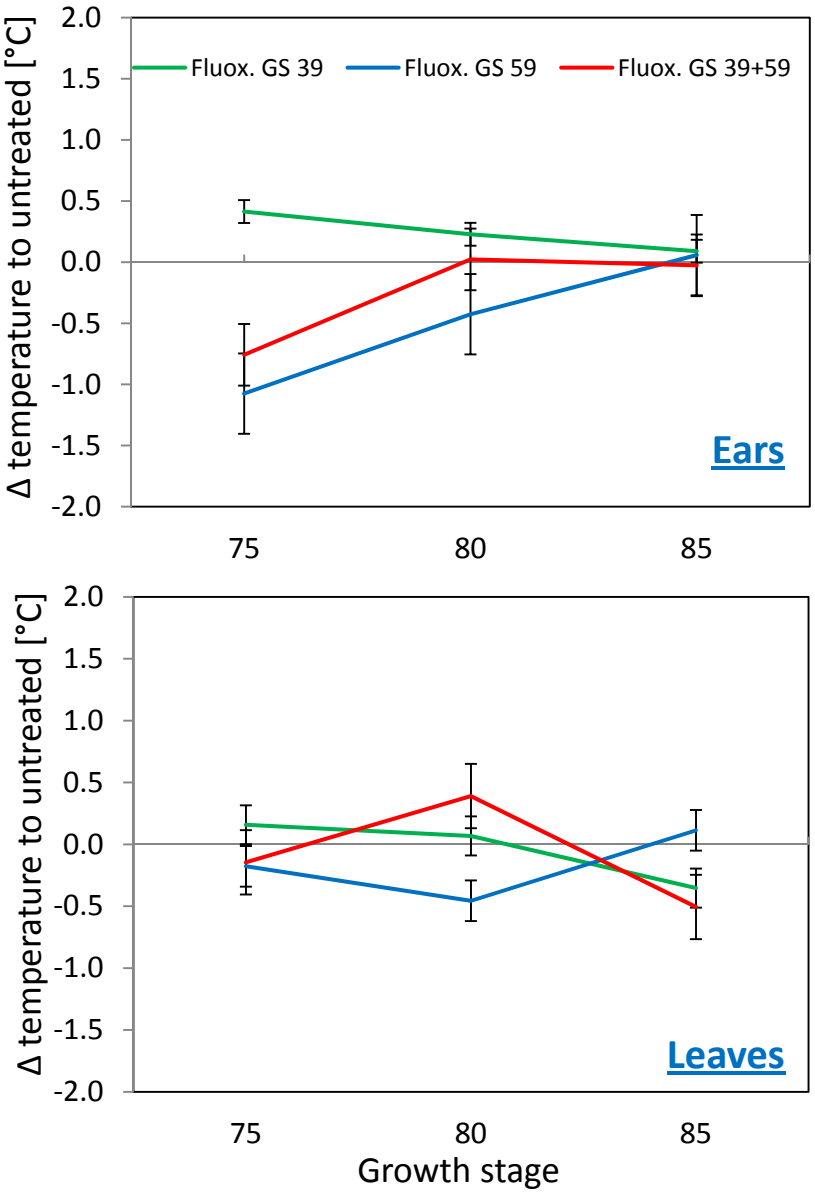
Thermography – Bixafen treatments



Thermographs at GS 85

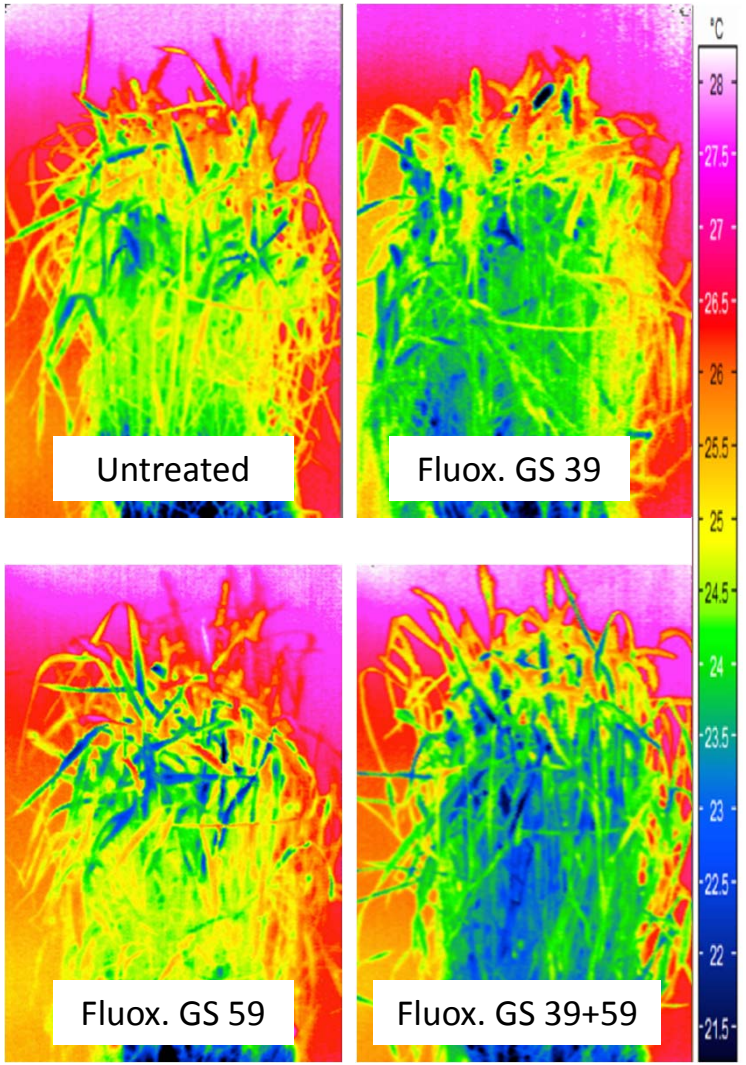


Thermography – Fluoxastrobin treatments

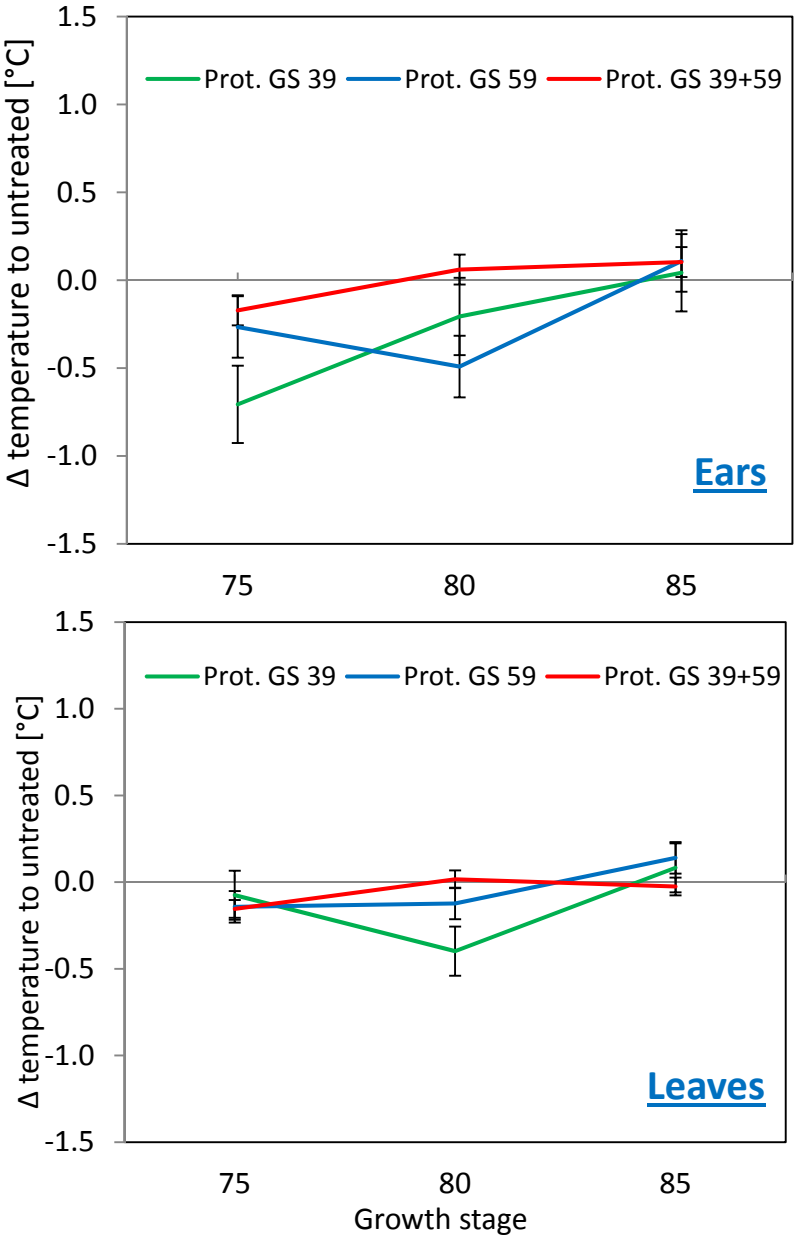


Standard error

Thermographs at GS 85

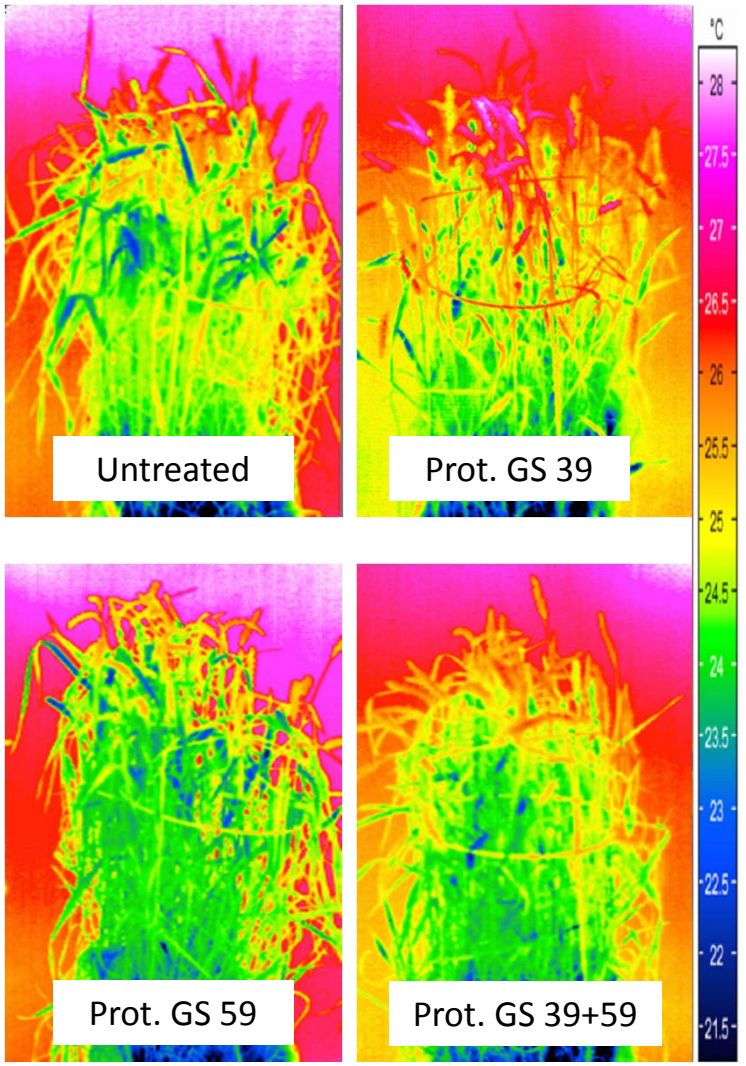


Thermography – Prothioconazole treatments



Standard error

Thermographs at GS 85



Conclusions

- ✓ The study demonstrated the potential of non-destructive sensors to assess plant senescence
  - alterations in the photosynthetic rate
  - changes in spectral reflectance of wheat plants
  - changes in chlorophyll content
  - differences in transpiration rate
- ✓ Differences between fungicide treatments were detected earlier (GS 75) by leaf reflectance compared to the other techniques
- ✓ Effect of fungicide application time on wheat physiology, it was fungicide dependent

Thank you for your attention

cberdugo@uni-bonn.de