ADA Meeting December 2014

Crop drought and heat impacts in Austria

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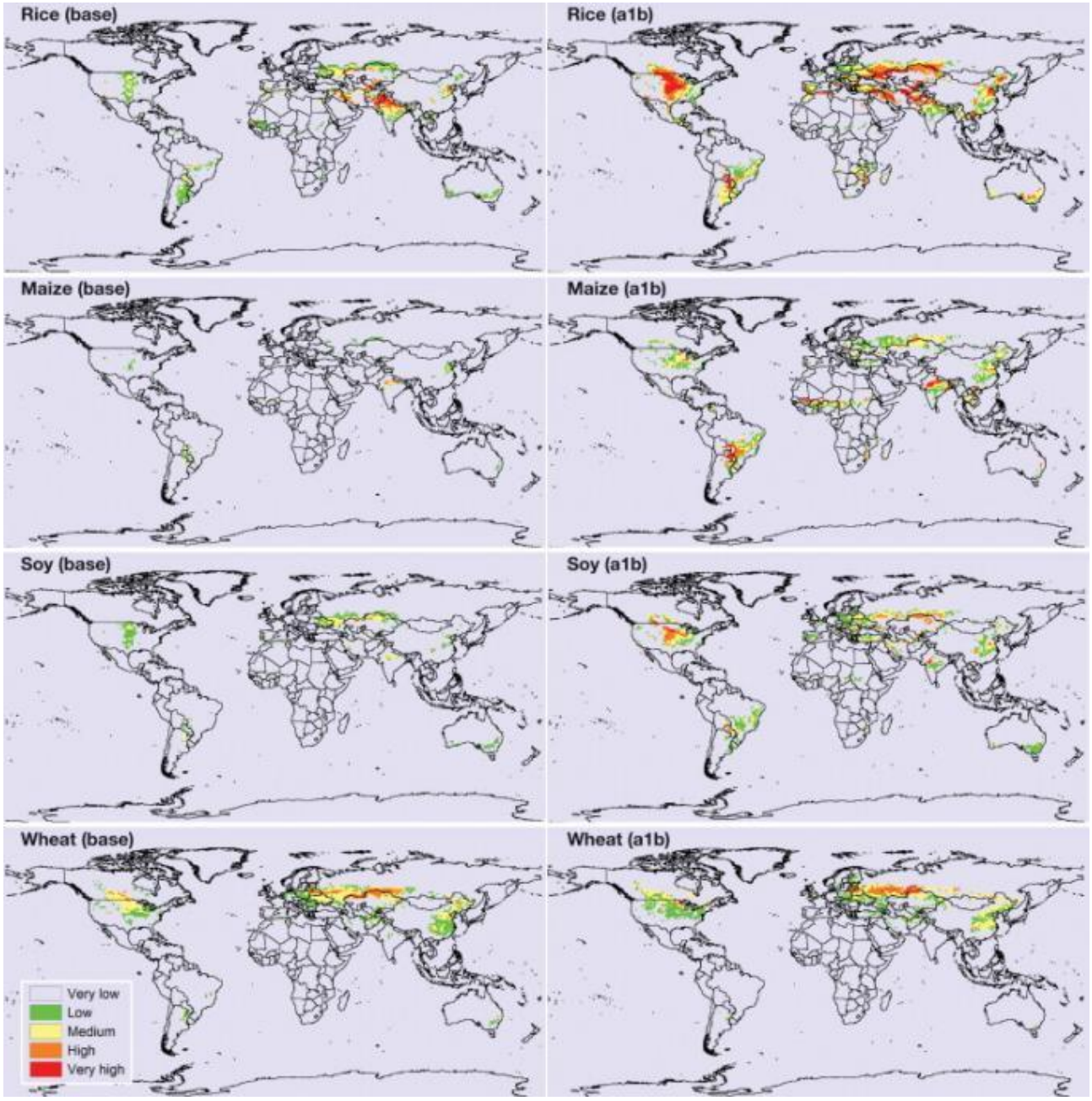


Globale heat stress

Teixeira et al., 2013, Agric. Forest Meteorol. 170

In some regions, yield losses might be rather a response to heat than to drought
(e.g. Semenow and Shewry 2011, Nature)

Still often separation is difficult.

Heat stress: Crop response and adaptation

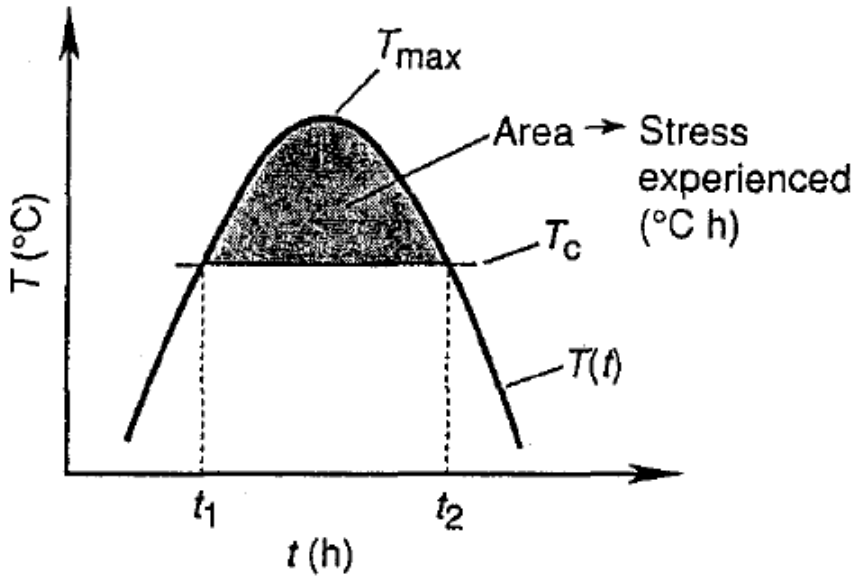
Effect	**Consequence**
Shortening of phenological stages	Shorter leaves and stems (lower radiation use), reduction in grain filling
Damage of fertilization	Reduced kernel setting (low sink strength)
Enhanced respiration	Lower net photosynthesis
Cell membran-instability (ROS; Symptoms: Electrolyte leaching)	Damage of photosynthesis and other metabolic processes

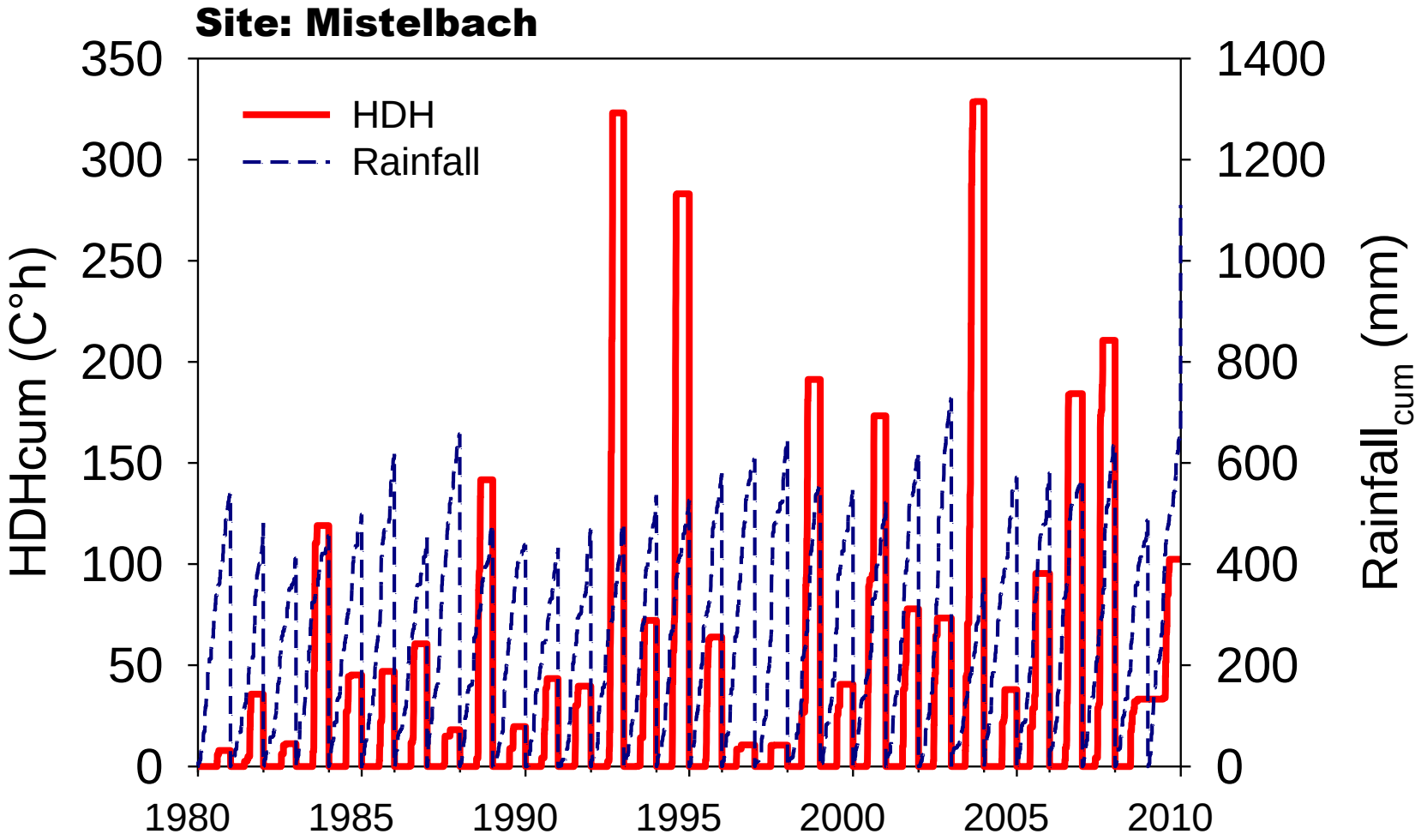
Response	
Phänological	Early ripening
Morphological	Leaf reorientation, epicuticular wax formation (radiation avoidance and reflection
Physiological	Synthesis of low molecular wight organic compounds, Xantophylls, Heat shock proteins, anti-oxidative compounds

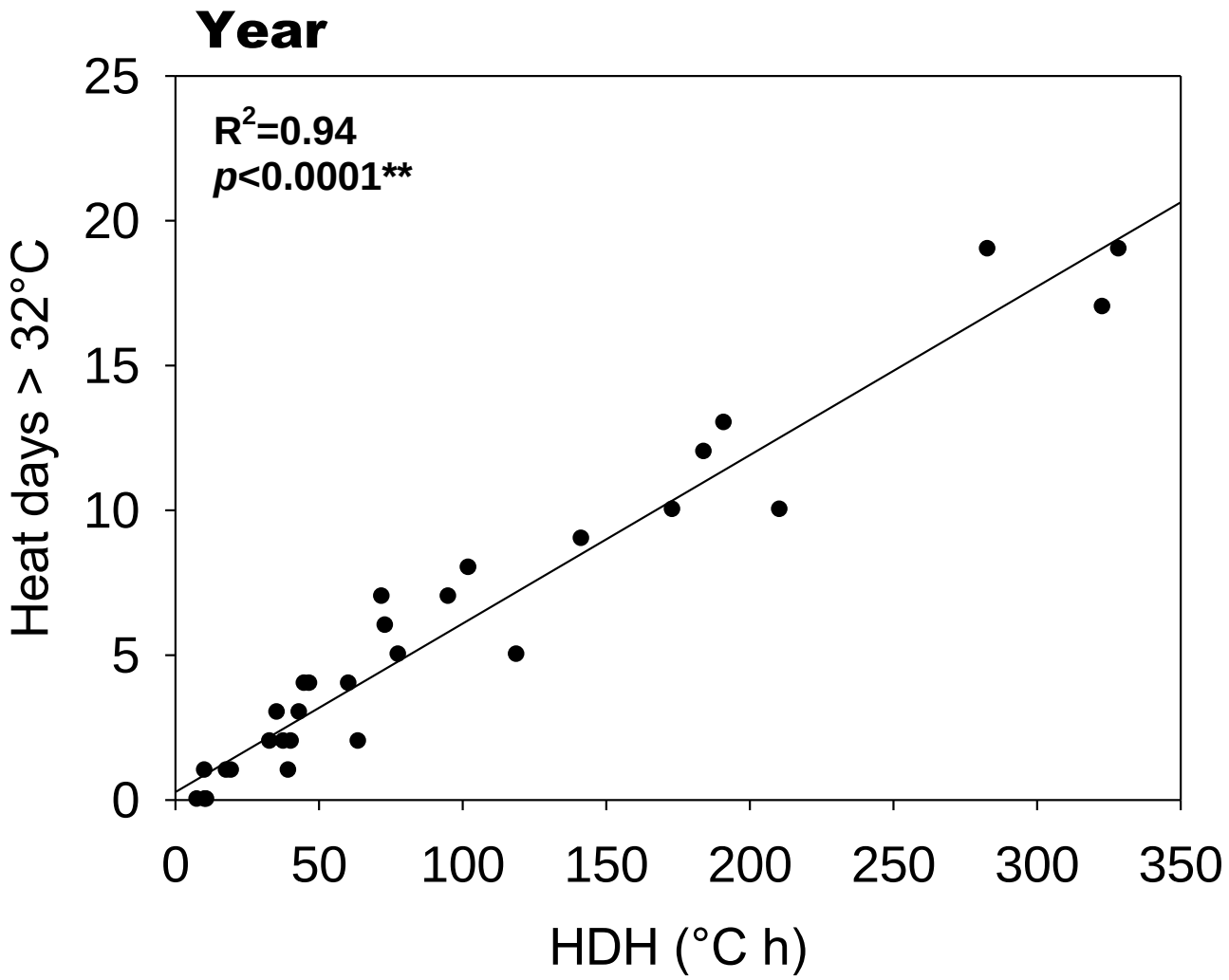
There are several heat stress indicators that could be tested.

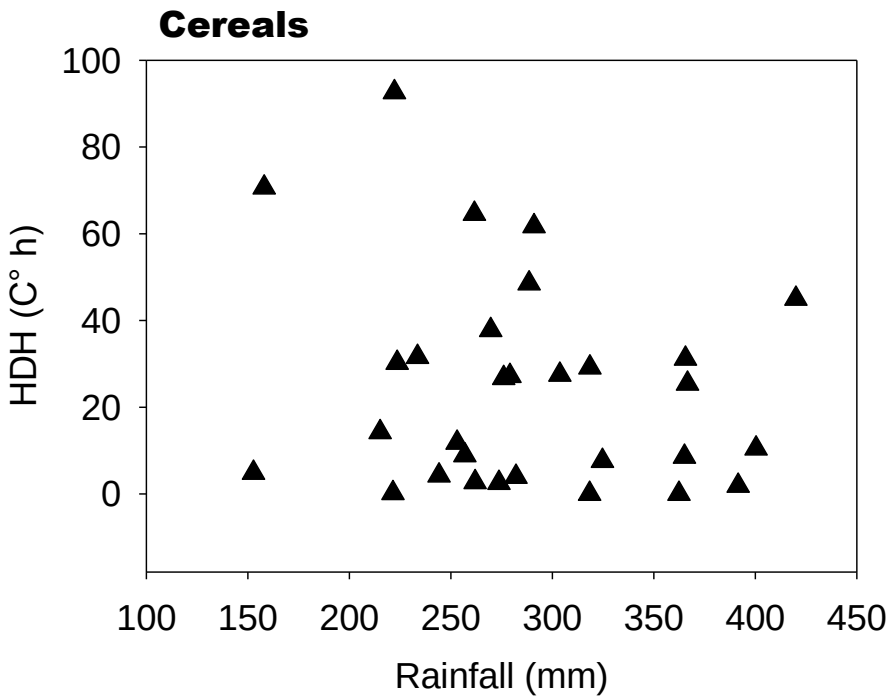
e.g. Number of days with temperature > Treshold temperature

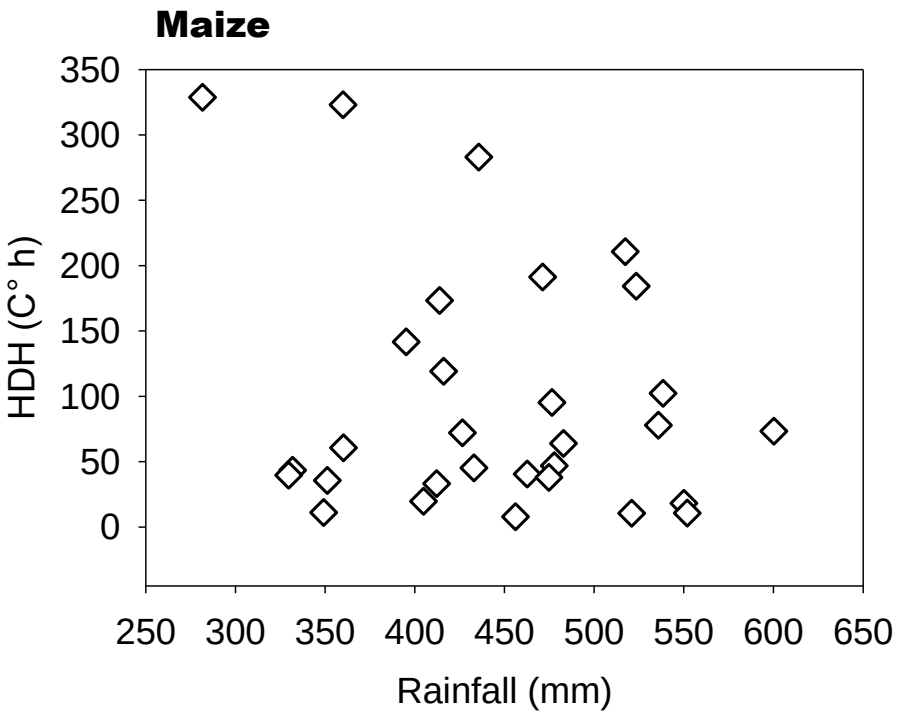
e.g. High degree hours (HDH, °C h; Bristow and Albrecht 1991, Aust. J. Soil Res. 29)

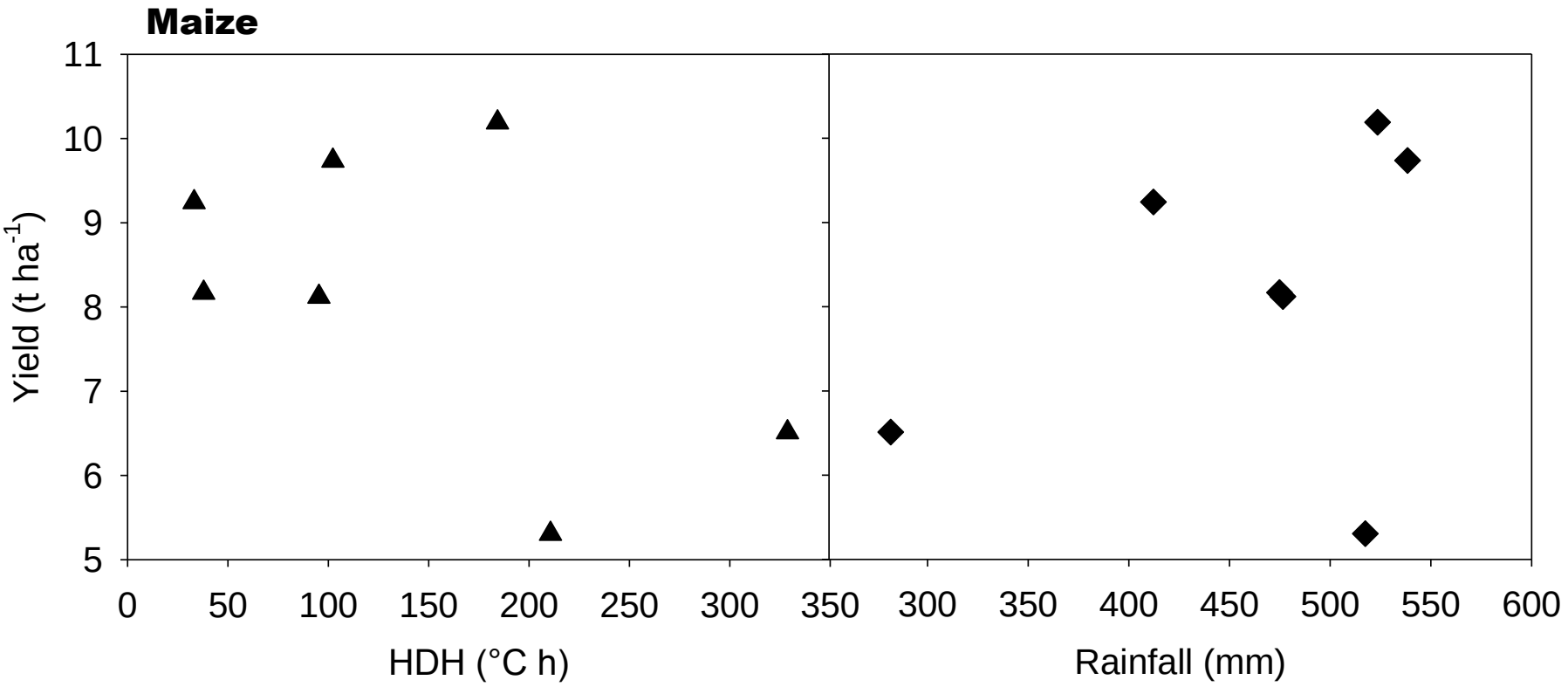


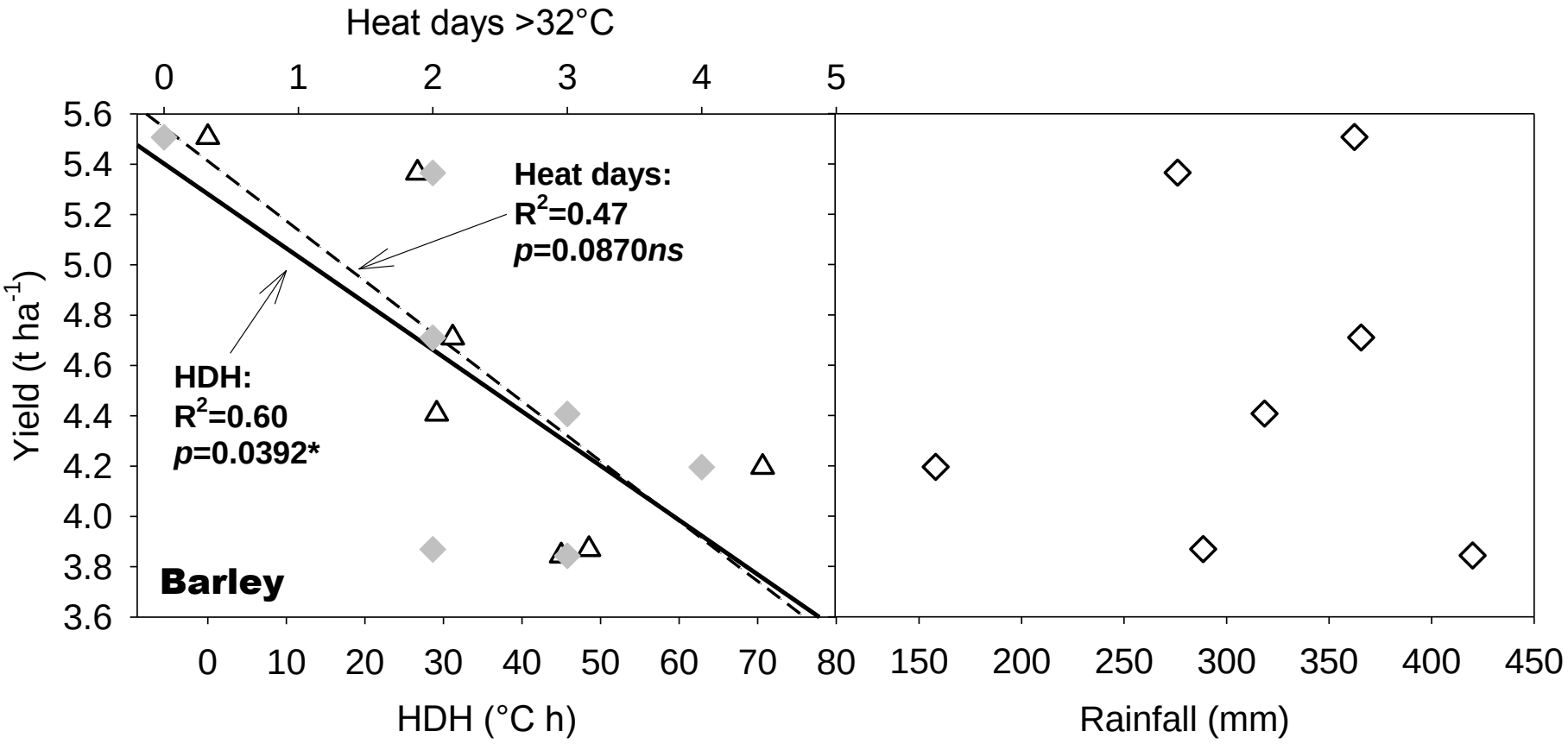

Site: Mistelbach
HDH
Rainfall
HDHcum (C°h)
Rainfall$_{cum}$ (mm)
350
300
250
200
150
100
50
0
1400
1200
1000
800
600
400
200
0
1980
1985
1990
1995
2000
2005
2010


Year
R^2=0.94
p<0.0001**
Heat days > 32°C
HDH (°C h)
0
5
10
15
20
25
0
50
100
150
200
250
300
350


Cereals
HDH (C° h)
100
80
60
40
20
0
100 150 200 250 300 350 400 450
Rainfall (mm)


Maize
HDH (C° h)
350
300
250
200
150
100
50
0
250 300 350 400 450 500 550 600 650
Rainfall (mm)


Maize
Yield (t ha-1)
11
10
9
8
7
6
5
0
50
100
150
200
250
300
350
300
350
400
450
500
550
600
HDH (°C h)
Rainfall (mm)


Heat days >32°C
0
1
2
3
4
5
Yield (t ha-1)
5.6
5.4
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
Heat days:
R2=0.47
p=0.0870ns
HDH:
R2=0.60
p=0.0392*
Barley
0
10
20
30
40
50
60
70
80
HDH (°C h)
150
200
250
300
350
400
450
Rainfall (mm)

Conclusions:

1.) **Heat stress** seems to be **very relevant** to explain variable yields – even more than drought stress.

2.) **Heat stress indicators and rainfall** are **not correlated**. To be tested with drought indicators and in terms of common yield effects (additive?)

Tasks:

Testing of **different indicators** for different crops (determine treshold temperatures).

Determination of **common use of stress indicators** (heat, drought) for yield loss prediction (dataset?)