Wheat Floret Development and the Relationship to Spike Temperature: The Interaction with Genotype and Stress

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Introduction

Similarly to Canopy Temperature Depression, **Ear Temperature Depression** is a physiological trait potentially useful to breeders aiming to screen genotypes for their ability to protect crucial stages of development from environmental stress.

The aim of this project is to develop a **new high throughput screening tool** for wheat breeders in both the UK and abroad, to select for a phenotype which is more tolerant to **abiotic stress** during flowering. The system has to be cheap to use, easy to implement, rapid and reliable and, most importantly, effective at the field level. At the core of this system, is **infrared** technology.

IR camera at work in the field at CIMMYT, NW Mexico (April 2013).

Objectives

Objective 1 – Determine the interactions between **spike temperature** and the **environment**, under abiotic stress.

Objective 2 – Quantify the relationship between **gross phenotype** of a number of Seri/Babax spring wheat and **abiotic stress tolerance**.

Objective 3 – Conceptualise and develop an **high throughput infrared screening tool** for wheat breeders in the UK and further afield.

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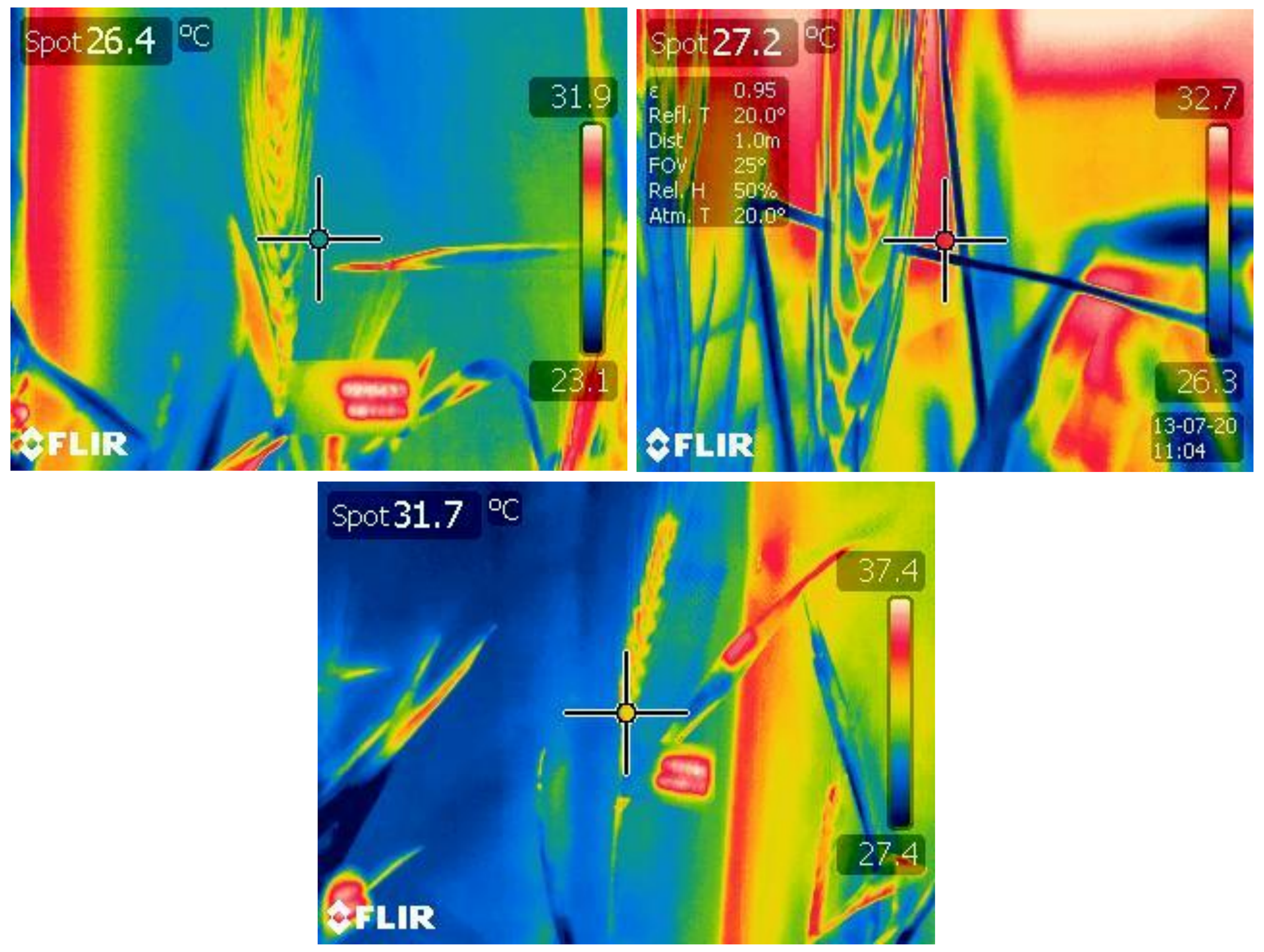
Methodology

- **Controlled environment** and **field scale** trials
- High and low yielding lines of **Mexican Spring wheat Seri/Babax**
- Scoring of **Floret Development Stage** and **infrared imaging** occur daily during flowering
- **Tissue samples** are taken during vegetative and reproductive phases and frozen in liquid nitrogen for **chlorophyll** and **soluble carbohydrate** extractions
- **Rapid** data collection (±15s per image)
- Highly **accurate** (±2 % of reading)

Differences in **ear temperature** between flowering stages suggest an active cooling response to the more **sensitive stages of flowering**.

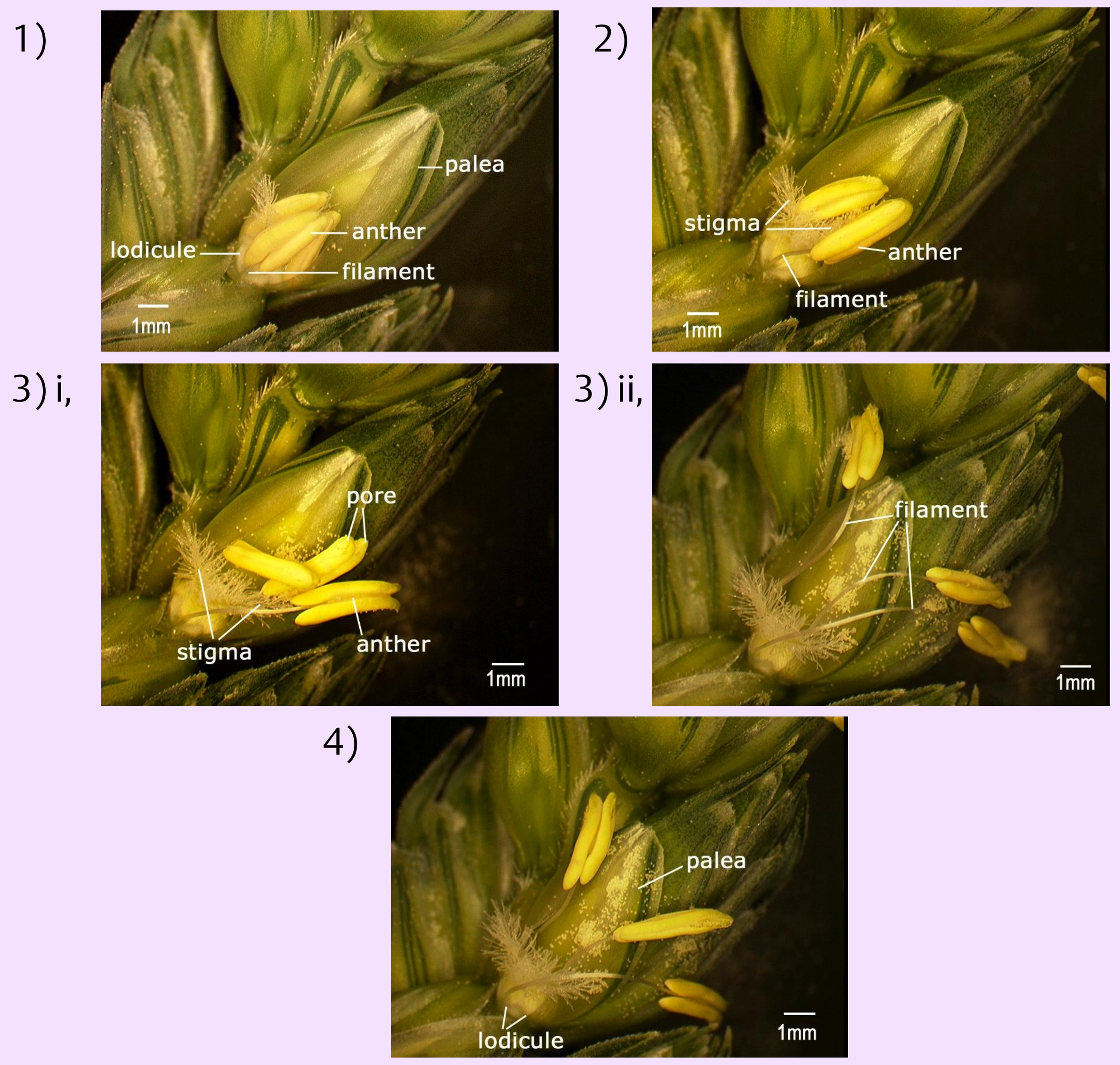


Infrared images taken of wheat ears at CIMMYT, NW Mexico (April 2013).

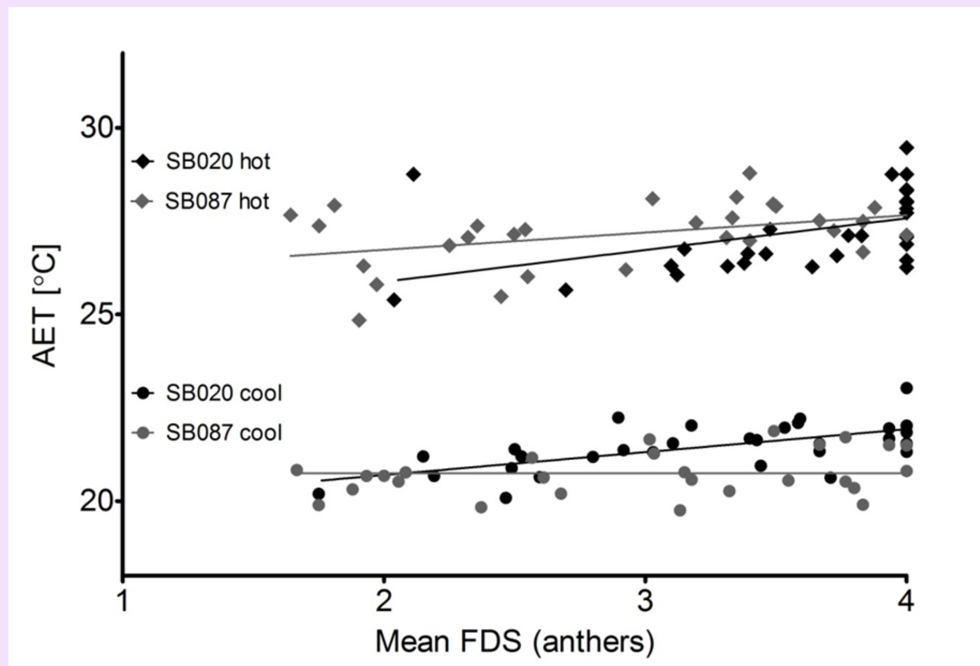
Collection of entire wheat plants in the field for detailed scoring in the laboratory at CIMMYT, NW Mexico (May 2013).

Floret Development Stage Scoring Technique

Differences in the **flowering synchrony** between the male and female organs, may be linked to different **protective adaptations**.



Images showing the stages of stigma and anther development in wheat. Stigma development is recorded in four stages: Half-Flowering (**HF**)*, Flowering (**F**), Post-Flowering (**PF**) and Grain set (**G**). Anther development is also recorded in four main stages (numbers do not correlate to picture labels): 1*, 2*, 3 and 4. Note: (*) denotes early anthesis and the most sensitive period to abiotic stress during anthesis. Images courtesy of www.wheatbp.net.

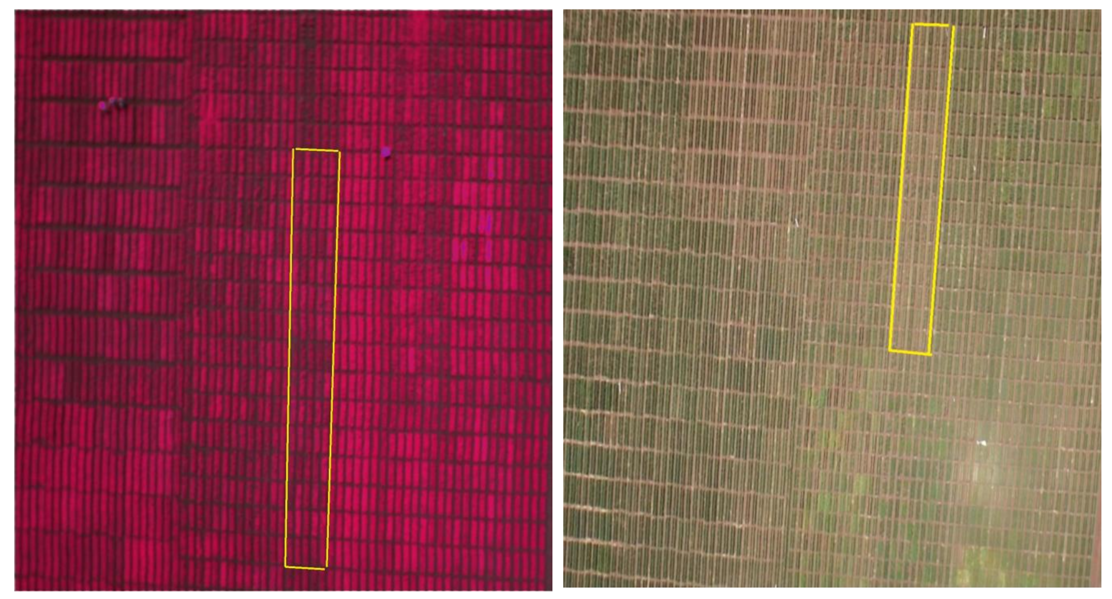


The relationship between mean Flower Development Score of anthers and Average Ear Temperature in two lines of Seri/Babax, in the 'Hot' and 'Cool' environments of a controlled environment trial. The slopes of linear fits did not differ between the lines in 'Hot' (P=0.307) or 'Cool' (P=0.091) treatments, however the increasing trend is significant both in the 'Hot' (P=0.003) and in the 'Cool' (P<0.001) environment.

UAV Multispectral Analysis

A **multispectral camera** attached to an eight rotor Unmanned Aerial Vehicle (**UAV**) was used to systematically image the field plots. When utilized in combination with the infrared camera, the differences in the scale of the images allows a **high throughput and detailed** approach to be developed. Alternatively to the UAV, the multispectral camera can be attached to a **helium filled blimp** which has to be manually walked through the fields.

Left: The multi-spectral camera, measuring in the spectral range of 400 – 900nm, attached to a UAV. *Right:* The helium filled blimp taking measurements of a field trial in Obregon, Mexico. Image courtesy of http://blog.cimmyt.org/?p=7892.



Left: The image generated by the multispectral camera from which the range of indices can be calculated. *Right:* A digital image of the field taken simultaneously to the multispectral image, in order to be able to identify reference points in the field. Images courtesy of Maria Tattaris, 2013.

The output from the multispectral camera can then be used to non-destructively compute a range of physiological indices, including **biomass**, **water content**, **albedo** and **canopy temperature**.

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