Adaptation research crops in Portugal – Tolerance of wheat varieties to climate change

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Climate change impacts are becoming apparent in the EU, where for example farmers in the different member states are already experiencing the impacts of severe weather events such as droughts, floods, and land-slides. Climate change can for example cause **decreasing wheat yields in parts of Europe (heat stress and reduced rainfall)**. Document concerning assessment of risk and vulnerability of agricultural systems to different climate change scenarios (EU, March 2015).

Overview of climate related risks in Europe, namely in the Mediterranean region, that will affect our farmers

**Crop season will be shorter** - there is a model estimated mean change in dates of flowering and full maturation for winter wheat for the period 2031–2050 compared with 1975–1994. Estimating a decrease in both from -25 to -10 days.

Source: EEA 2012, Climate change, impacts and vulnerability in Europe 2012
A group of Parties noted that urgent action is required in order to improve productivity and promote the adaptive capacity of agriculture as it may not be possible to return to previous production conditions.

Several Parties emphasized the importance of involving risk and vulnerability assessments in identifying adaptation measures suited to local circumstances and productive systems. Such measures included, inter alia, the development of improved seed varieties adapted to new agro-climatic conditions, heat/water stress and exposure to different pests.

South of Portugal as a future scenario of what will happen in Mediterranean region of France. ARVALIS discuss with INIAV the possibility of working together in wheat tolerance and adaptation to rising temperatures – exploring genetic variability (Portuguese germplasm).

Wheat Ideotype South Project
Focusing cooperation activities, sharing knowledge, exchanging experts, technology transfer, capacity-building, learning from each other with a particular focus on research of crops adaptation to heat stress – tolerance of wheat varieties to climate change.
Wheat Ideotype South Project

Definition of wheat variety type (ideotype South) in face of current and future climate risks in the Mediterranean region of southern Europe

- Since 2011 - Common trials of bread and durum wheat in Portugal and France
  - **Portugal**
    - INIAV - research institute, Ministry of Agriculture
    - ANPOC - Portuguese farmer’s association for cereals and pulses
  - **France**
    - ARVALIS, Institut du Végétal - agricultural applied research French organization

- 2015: Tunisie INGC
- Near future: Spain IRTA
 Goals

- To study and evaluate the performance and response of French and Portuguese bread and durum wheat varieties and advance lines obtained by INIAV, in both countries.

- To define best fit traits of a new plant (wheat) ideotype enabling agricultural systems adaptation to major environmental constraints - climate change.
  - Exploring Portuguese germplasm - genetic variability
  - Adaptation strategy to fight against climate change impacts on crops yields - Breeding new wheat varieties

- To adjust inputs management (nitrogen, water, pesticides) fitting on-going crop season potential - climatic potential, increasing inputs use efficiency
Climate data

Physiological Diseases data

Variety selection "Ideotype South"

Phenotyping

High intensity level
Phénomobile Gréoux

Low intensity level
Elvas, Gréoux, Tunisie...

Association genetics

Analyse des risques climatiques

Using ARVALIS Models

Crop management adjusted to season potential

Multilocal diagnostic of limiting factors (yield gap)

ANPOC + Farmers

Screening Portuguese germplasm – genetic variability

Low intensity level
Elvas, Gréoux, Tunisie...

High intensity level
Phénomobile Gréoux
Daily maximum temperatures during wheat grain filling supports the idea that heat stress is stronger at Elvas than at Gréoux-les-Bains

<table>
<thead>
<tr>
<th>Climate data</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>PT</td>
<td>FR</td>
<td>PT</td>
</tr>
<tr>
<td>Rainfall</td>
<td></td>
<td></td>
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<tr>
<td>Total rainfall (mm) (1oct - 30 jun)</td>
<td>239</td>
<td>551</td>
<td>589</td>
</tr>
<tr>
<td>Winter rainfall (mm) (jan, feb, mar)</td>
<td>8</td>
<td>37</td>
<td>263</td>
</tr>
<tr>
<td>Spring rainfall (mm) (apr, may, jun)</td>
<td>74</td>
<td>201</td>
<td>38</td>
</tr>
<tr>
<td>Number of days with rainfall (1oct - 30 jun)</td>
<td>60</td>
<td>92</td>
<td>107</td>
</tr>
<tr>
<td>Temperatures - heading + grain filling (1 apr - 15 jun)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average of max. Temp. (°C)</td>
<td>24.4</td>
<td>21.9</td>
<td>24.4</td>
</tr>
<tr>
<td>Number of days temp &gt;25°C</td>
<td>35</td>
<td>26</td>
<td>39</td>
</tr>
<tr>
<td>Number of days temp &gt;30°C</td>
<td>20</td>
<td>4</td>
<td>13</td>
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- Total rainfall in southeast France was always higher than in the south Portugal.
- Major difference between Elvas and Gréoux-les-Bains is the rain distribution during spring, which is markedly more irregular (and scarce, 2012 and 2013) at Elvas concerning the quantity (mm) and the distribution (number of days with precipitation).
- The significant difference that is noted for the number of days with temperatures above 25°C and 30°C, during this period, confirms that wheat crop is submitted to a much more severe stress in Portugal, which was the main reason why ARVALIS decided to join Portuguese cereal group to conduct trials in this environment, facing future scenarios that are expected as a consequence of climate change that may occur in Mediterranean south region of France.
2014/15 season

- 1 feb to 15 june -> Total rainfall = 327 mm
- Rain occurred in 28 jours

1 april – 15 june (GF)
- Average max temp = 24.7°C
- 40 days T max > 25°C
- 9 days T max > 30°C

1 feb to 15 june
- Total rainfall = 178 mm
- Rain occurred in 17 jours

1 april – 15 june (GF)
- Average max temp = 28.4°C
- 50 days T max > 25°C
- 32 days T max > 30°C

Average T max (°C)

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</thead>
<tbody>
<tr>
<td>Elvas</td>
<td>25</td>
<td>22,4</td>
<td>24,2</td>
<td>26,9</td>
<td>33,8</td>
<td>32,1</td>
<td>36,4</td>
</tr>
<tr>
<td>Gréoux</td>
<td>18,5</td>
<td>21,4</td>
<td>21</td>
<td>25,4</td>
<td>26,7</td>
<td>25,8</td>
<td>32</td>
</tr>
</tbody>
</table>

Heading + Grain filling
More days with temperatures > 30°C during grain filling in Elvas vs Gréoux higher heat stress
**Durum Wheat**
- PT 23 Feb
- FR 26 Feb
- Stem elongation + booting
- GF 27 Oct
- PT 18 Feb
- FR 28 Feb
- Stem elongation + booting
- GF 15 Jun

**Bread Wheat**
- PT 27 Feb
- FR 13 Mar
- Stem elongation + booting
- GF 15 Jun
- PT 19 Feb
- FR 28 Feb
- Stem elongation + booting
- GF 2 Jun

**Grain Filling**
- PT 31 Mar
- FR 7 Apr
- Duration: 2 Jun

**Heading**
- PT 28 Apr
- FR 1 May
- Duration: 15 Jun

**Stem elongation + booting**
- PT 1 Apr
- FR 12 Apr
- Duration: 2 Jun
Identifying adaptation measures – an example: precocity at heading time and terminal spikelet time
In the southeast France varieties bred in France were superior in yield, when compared with the genotypes bred at INIAV (Portugal). More evident in bread wheat.

Portuguese varieties showed good plasticity with similar yield in both sites (Portugal and France).

French varieties had lower yields at Elvas trials than in Gréoux-les-Bains. The difference was lower in durum wheat.
In Portugal, yield was not significantly different comparing rainfed and irrigated conditions. Despite a dry winter (72 mm), rainfall in April (110 mm), made possible the germplasm recovery.

At Gréoux it was found a significant difference between water conditions (rainfed vs. irrigated).

In France, bread wheat PT varieties showed similar yield (7432 kg/ha) when compared with that obtained in Portugal (7234 kg/ha).

French wheat varieties suffered a lot under higher heat stress, as it is common in the south Portuguese Mediterranean environment.
Common trials of bread and durum wheat in Portugal and France

2011/2012, INIAV Elvas

2011/2012, Torre do Frade
Team collecting data in June 2014 at Arvalis experimental station (Gréoux-les-Bains, PACA region, France)

Team meeting in February 2015 at Portuguese trials at INIAV research station (Elvas)
MUITO OBRIGADA

DANK U

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