GRAIN SIZE AND PROTEIN CONTENT RESPONSE TO LATE HEAT AND DROUGHT STRESS IN WINTER WHEAT LANDRACES IN THE ATLAS MOUNTAINS OF MOROCCO

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Introduction

Wheat is a major staple crop for a large part of world population. In Morocco, wheat is grown on 2.95 Million hectares with an average yield of 2.1 tons/ha (FAOSTAT, 2017). Wheat consumption per capita in Morocco is estimated at 173 kg annually, which is among the highest in the world. In 2016 the gap between consumption and production is about 6.3 Million tons. Sowing date influence negatively the growth, yield and the grain shape of wheat. In the highlands of Morocco (home to over 200.000 families and characterized by cold winters and late heat and drought stress) where straw is valued as animal feed and yields rarely exceed 1 t/ha, wheat landraces can be sources of tolerance traits to mitigate the expected heat and drought to come or can even be considered for direct use to increase production and ensure food security. The aim of this study was to analyze the effect of late heat and drought stress in traits related to grain morphology and composition.

Materiel & Methods :

- **Plant material**

Forty-one winter and facultative wheat landraces obtained from the ICARDA gene bank and collected from Azerbaijan, China, Georgia, Turkey and Tajikistan. All this lines were Photoperiod and vernalization insensitive.

- **Grain morphology :**

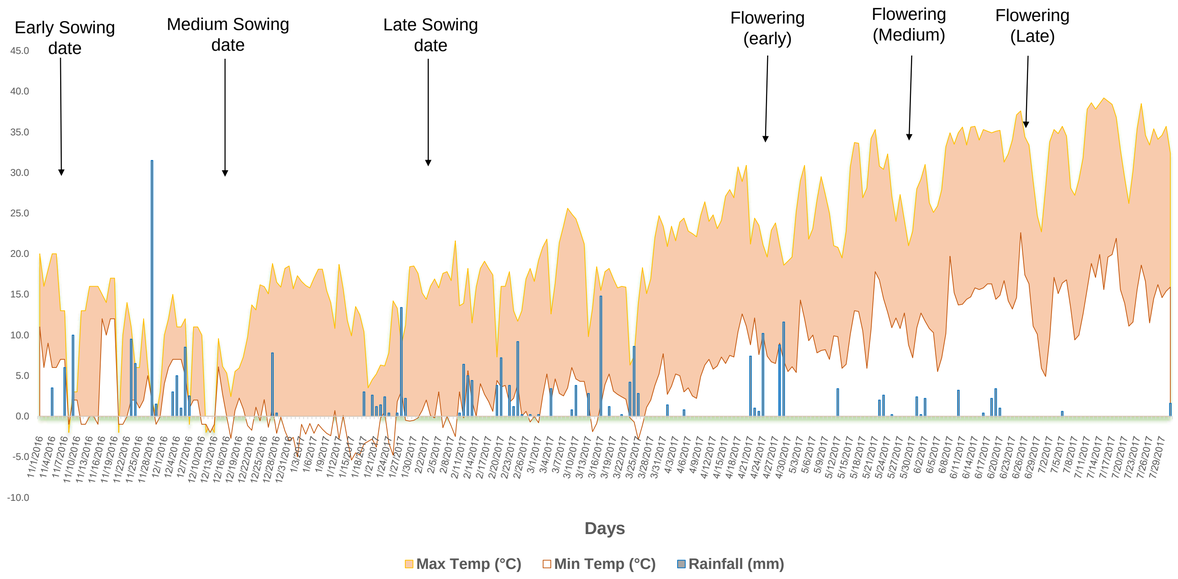
Measurements of grain morphological parameters (length, width, area and perimeter) and color were determined using a scanner and the Grainscan software developed by (Whan et al. 2013). A random sample of 200 seeds was analyzed per plot. Additionally, the protein level was assessed by the Near Infrared spectroscopy (NIRS) method using an in-house calibration developed at the ICARDA quality laboratory.

- **Experimental design and data analysis**

The 41 landraces were tested following an augmented design using 4 check varieties (NEKOTA, SERI82, SONMEZ and OR9801757) at Annoceur research station (33°41'05.2"N 4°51'19.9"W) in the highlands of Morocco. In this experiment, 3 sowing dates (Early November, mid December and Early February) were used to simulate the potential effects of climate change in the region.

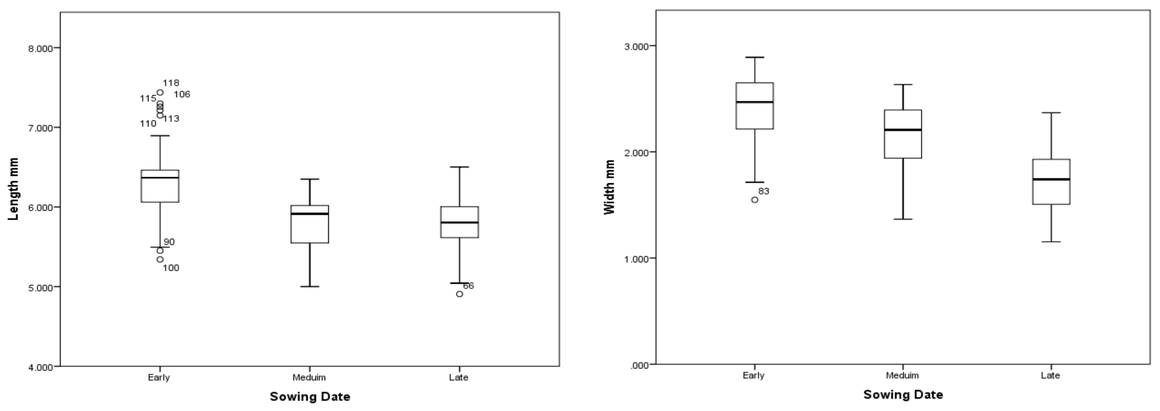
Results and discussion :

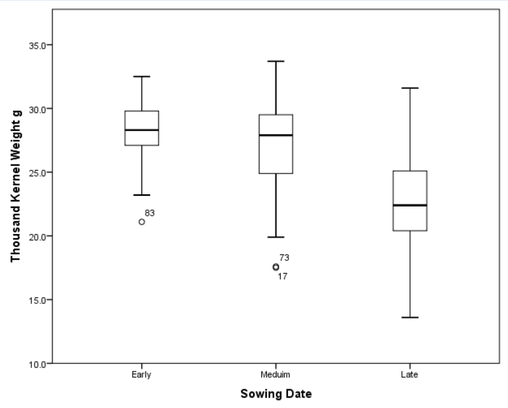
Figure 1 – Temperature and rainfall pattern in 2016-2017 at Annoceur Research station



During grain filling period, 57.6, 22, 15 mm were recorded for Early, Medium and late sowing dates respectively. While the maximum temperature was 29, 34 and 35 °C for Early, Medium and late sowing dates respectively before flowering.

Figure 2 – Boxplot of grain length, width, weight and protein content obtained from 41 landraces grown on three planting dates



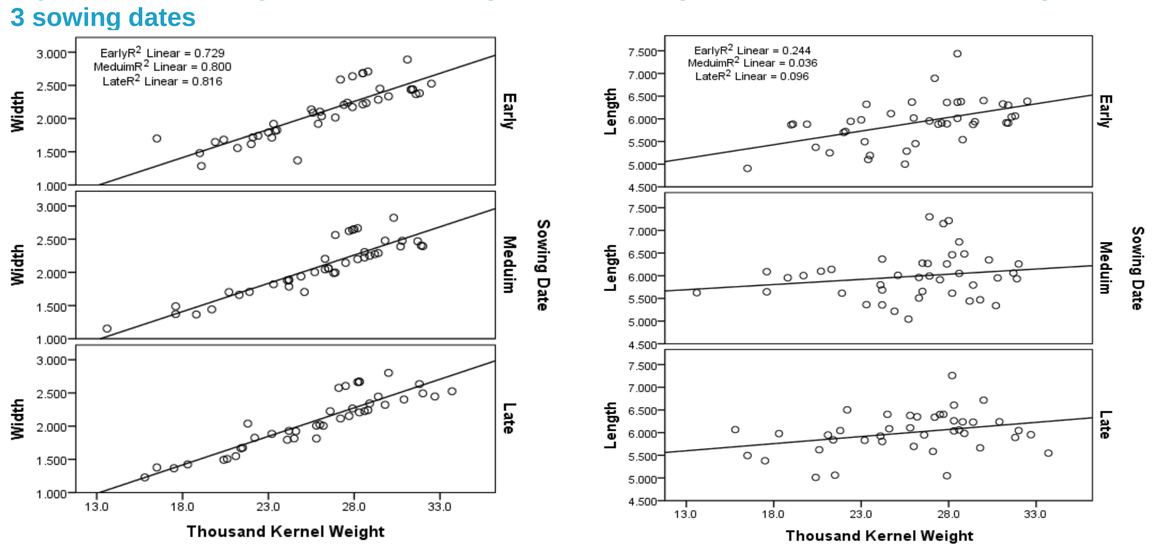


Grain length, width and weight showed a significant decrease from the early to late sowing date, while grain protein content showed the opposite trend. The grain protein increase is possibly due to the protein dilution effect under the low stressed Early and Medium dates as compared to the Late one, due to an increase in carbohydrates in the grain as suggested by the higher thousand kernel weight (TKW).

Figure 3 – Percentage of the model variance explained by Genotype, Sowing date and the interaction

The effect of the planting dates was higher on TKW and grain width (42% and 25% of the variance explained by the interaction between the climate and the genotype respectively), while it was 13%, 17%, 17%, 22% for area, Length, TKW and protein respectively. However the higher Genotype effect was for protein with 67% and 57 for area.

Figure 4 – Linear regression between grain width, length and Thousand kernel weight across 3 sowing dates



Thousand kernel weight showed the highest association with grain width, specially under the last planting date. This, result suggest that, under severe abiotic stress conditions, differences in grain width are the main driver of TKW and therefore it is a trait of importance when breeding for Climate Change adaptation.

Table 1 – List of landraces showing the lowest grain weight lost across sowing dates

Name	Origin	Grain width loss for Medium sowing date	Grain width loss for Late sowing date
1-196	China	**1%**	**5%**
XIANG YANG 1	China	**2%**	**6%**
TJK2006:038	Tajikistan	**3%**	**5%**
Best check (SERI82)	Mexico	**13%**	**29%**

Finally, three landraces originated in China and Tajikistan were able to tolerate environmental stress and their decrease was only by 1-3% for the Medium sowing date and 5-6% for the late sowing date. As compared to the best modern check, these landraces showed lower grain width decrease and higher TKW under the most stressed conditions. The results showed that landraces have the potential of bringing new tolerance traits to climate change especially to the low input highlands of Morocco.

Acknowledgment

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References

Whan et al. (2014). GrainScan: a low cost, fast method for grain size and colour measurements. Plant Methods 10: 1.