KERNEL GROWTH AND QUALITY TRAITS OF MAIZE HYBRIDS WITH DIFFERENT END-USE AT CONTRASTING POST-FLOWERING THERMAL ENVIRONMENTS

FAUBA

CONICET

Luis I. Mayer[12], Raziel A. Ordóñez[3], Roxana Savin[3], Alfredo G. Cirilo[4] and Gustavo A. Maddonni[12].
[1]Department of Vegetal Production, FA-UBA. [2]IFEVA-CONICET. [3]Department of Crop and Forest Sciences, University of Lleida. [4]EEA - INTA Pergamino. mayer@agro.uba.ar

Universitat de Lleida

INTA

INTRODUCTION

Global warming is mostly associated to long-term positive variations of temperature, even though many agricultural areas are also subjected to abrupt rises of diurnal temperature [1]. Temperature is a major factor governing (i) kernel growth dynamic, by means of its effect on rate and duration of the effective grain-filling (EGF) period [2], and (ii) the structural and chemical kernel composition. In this context, productive scenarios for the future will require new strategies and crop husbandries to sustain or improve grain yield and/or kernel composition.

Objective: to asses kernel weight (KW) and its relative structural and chemical composition for maize hybrids of different industrial uses, cropped under contrasting post-flowering thermal environments.

MATERIALS AND METHODS

Field experiments (Exp.1 and Exp.2) conducted during 2009-2010

Exp.1: Argentina. **Location**: 34 35 S 58 29 W; 26 masl. **Treatments:** Factorial arrangement with three replicates of (i) three grain maize hybrids, flint: ***Mill522***; semi-dent: ***2A120HX*** and pop-corn: ***P802***; (ii) 15-d heating periods at two stages of the EGF, early: **ES** and late: **LS**; and (iii) two thermal environments, non-heated control: T_C and heated: T_H (temperature at ear level >35 C around noon). T_H was achieved by means of small greenhouses covered by transparent polyethylene film.

Exp.2: Spain. **Treatments:** Factorial arrangement with three replicates of (i) two maize hybrids, a grain: ***Pioneer*** *31N28* and a forage one: ***Lapopi***, (ii) two nitrogen supplies, non-fertilized: **N0** and 200 kg N ha^{-1}: **N1**; and (iii) two locations of different post-flowering thermal environments, *Montferrer:* **cooler** (42 20 N, 1 25 E; 820masl) and *Algerri:* **warmer** (41 49 N, 0 38 E; 345masl).

Crop husbandry: Plant density: 8.4-9 pl m^{-2}. Experimental unit: 6 m^2 (Exp.1); 40-50 m^2 (Exp.2). Crops were irrigated, without nutrient limitations (only Exp.1), free of pests, weeds and diseases.

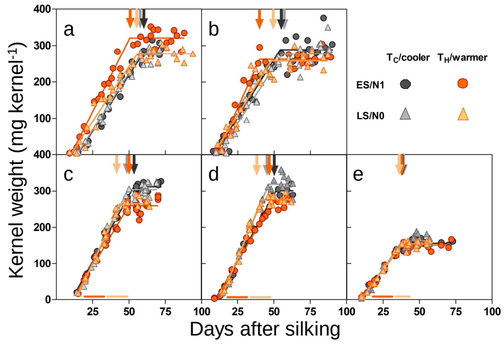
Measurements: (i) evolution of endosperm, embryo, pericarp and kernel weights, (ii) starch, oil (only Exp.1), and protein kernel concentrations at maturity by NIR and (iii) relative content of endosperm storage proteins (α-, β-, and γ-zeins) at maturity by monolithic RP-HPLC [3].

RESULTS AND DISCUSSION

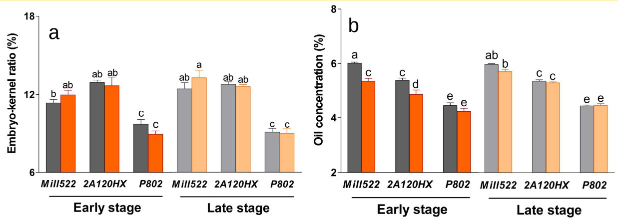
1. Kernel growth dynamic

- Higher temperatures determined lighter KWs (between -10 and -15%), which were mainly promoted by a shorter (p<0,001) EGF period (Fig.1a,b,c,d). Interestingly, KW dynamic of *P802* hybrid was not affected by heating (Fig.1e).
- In Exp.2 higher temperatures also increased the grain-filling rate, but this effect was of a lower magnitude than that on the EGF duration (Fig.1c,d).
- At the cooler location *Pioneer* hybrid was affected by early frosts determining a premature cessation of the EGF period, and thus, a similar (N0) or lower (N1) KW than that exhibited at the warmer location (Fig.1a)
- Nitrogen restriction in Exp.2 diminished KW (p<0,02), and this response was due to a lower grain-filling rate (Fig. 1 a,b).

Fig. 1. Kernel growth dynamic on of five maize hybrids, Pioneer (a), Lapopi (b), Mill522 (c), 2A120HX (d), P802 (e) under different post-flowering thermal environments. In c, d and e horizontal lines represent the occurrence and duration of the heating treatment. Arrows indicate physiological maturity. Lines described models fitted to data set of each hybrid and thermal environment .



2.1 Structural and chemical kernel composition: Oil



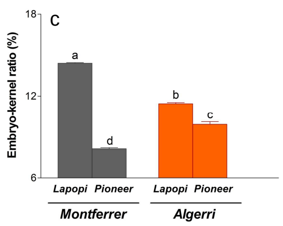


Fig. 2. Embryo-kernel ratio (a,c) and oil concentration (b) of different maize hybrids cropped under non-heated/cooler (grey symbols) and heated/warmer (orange symbols) post-flowering thermal environments.

- In Exp.1 embryo weight (main organ of oil allocation) exhibited the same response pattern than that of KW (data not shown). Hence, embryo-kernel ratio was never affected by T_H (Fig.2a). However T_H reduced oil concentration (from 7-7,5 to 6-6,5%) of *Mill522* and *2A120HX* (Fig.2b). In contrast, oil concentration of the *P802* hybrid did not change under the different temperature regimes.
- In Exp.2 the warmer location decreased the embryo-kernel ratio of *Lapopi* hybrid, which possibly would led to an oil concentration reduction. The opposite response was found for *Pioneer*.
- Higher temperatures decreased the pericarp-kernel ratio of all hybrids only at ES in Exp.1, whereas in Exp.2 the same trend was only found for *Pioneer* (data not shown).

2.2 Structural and chemical kernel composition: Protein

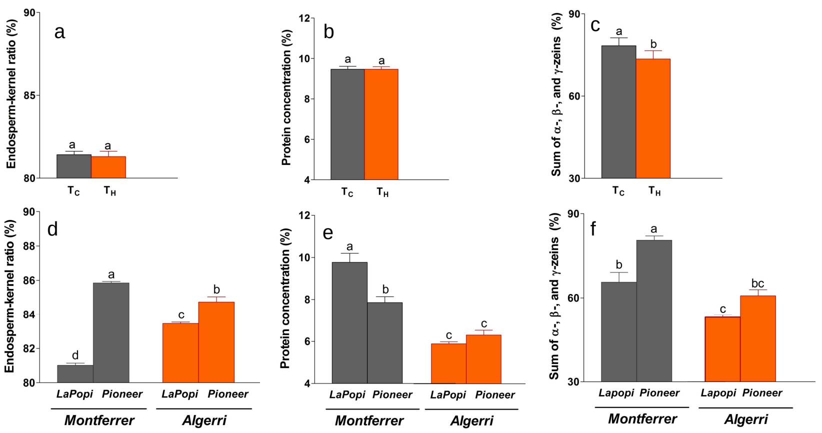


Fig. 3. Endosperm-kernel ratio (a,d), protein concentration (b,e) and relative content of endosperm zeins (c,f). Symbols as in Fig.2.

- In Exp.1 both endosperm (main organ of protein storage) and KW were affected similarly by T_H, provoking no variations in endosperm-kernel ratio and protein concentration (Fig. 3a,b).
- In Exp.2 high temperatures strongly decreased protein concentration, specially that of *Lapopi* (from 9,7% to 5,9%, Fig.3e).
- The relative content of zeins (storage proteins positively related to endosperm hardness) always had an increment under cooler thermal environments (Fig.3c,f). Moreover, most of this variation (60-70%) was accounted for by the relative content of α-zeins.
- In Exp.2, N1 increased protein concentrations for all hybrid location combinations (data not shown).

CONCLUSIONS

- Warmer post-flowering environments, due to either a higher mean temperature or abrupt rise of diurnal temperature, shortened the EGF period determining reductions of KW, oil concentration and relative content of zeins. Contrarily, protein concentration was diminished only by increases of mean temperature.
- Only the *P802* hybrid, with the smallest KW, had a stable response of mentioned traits to warmer post-flowering conditions.
- Other industrial parameters should be tested to provide a deeper understanding of the impact of global warming on grain quality.

References

[1] IPCC, (2007). IPCC, Ginebra, Suiza, p. 115. [2] Jones R.J., Quattar S., Crookston R.K. (1984). Crops Sci. 24:133-137. [3] Rodríguez-Nogales J.M., del Alamo M., García M.C., Cifuentes A., Marina M.L. (2009). Journal of Agricultural and Food Chemistry 57, 3014-3021.

This work was financed by the Regional Fund for Agricultural Technology (project 8031)

FONTAGRO