# KERNEL WEIGHT DETERMINATION IN MAIZE INBRED LINES AND DERIVED HYBRIDS

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## INTRODUCTION

In maize, kernel growth rate during the effective grain-filling period (KGR) and grain-filling duration (GFD) are responsible for variations in final kernel weight (KW). Both determinants of KW vary independently. They are associated with different physiological processes [2], showing great variability according to genotype (inbred lines and hybrids), enviroment, crop management and all their interactions.

KW and its physiological determinants have mean to high heritability level [1, 6]. However, knowledge on the genotypic variation and genetic control of mentioned traits is limited.

**The OBJECTIVES of this research were (i) to assess genotypic variation of KW and its physiological determinants (KGR, GFD), and (ii) to establish the heterosis, heritability and combining ability levels for these traits. A complete diallel mating design under contrasting N conditions was used for this purpose.**

## MATERIALS AND METHODS

**Field experiments:** performed during 2013-2014 at INTA Pergamino research station (33º 93'S, 60º 55' W), Argentina.

**Treatments:** 4 inbred lines (B100, LP2, LP662, ZN6) and their derived hybrids (12, including reciprocal) in a factorial combination of genotypes and two N levels (N0: no fertilizer added; N1: 200 kg N ha$^{-1}$ supplied as urea).

**Experimental design:** split plot organized in three randomized complete blocks, with N availability in the main plots and genotypes in the subplots.

**Crop husbandry :** Stand density: 7 pl m$^{-2}$. Plot size: 8.4 m$^2$. Sowing date: 28-Oct-2013. Sprinkler irrigation throughout the cycle. Permanent control of pests, weeds and diseases.

**Measurements and estimated parameters:** A total of 12 plants were tagged in each plot, and the date of silking was registered on all these plants. The apical ears of 10 tagged plants were collected each 5 days from 15 days after silking onwards, and 15 grains per ear were sampled from the 10th (bottommost) spikelet position. Kernels were oven dried and weighed for the determination of KW, KGR and GFD by fitting a bi-linear model [5].

**Statistical analyses:** ANOVA (mixed model analysis), Pearson's regression analysis, mid parent heterosis (MPH), broad sense heritability (H$^2$) [3], general and specific combining ability (GCA; SCA) [4].

## RESULTS

Significant genotypic (**G**), hybrid (**H**) and Inbred (**I**) effects (P<0.01) were detected for all measured traits, except for **KW** that had no significant **I** effect (Table 1). It was found (i) no significant nitrogen (**N**) effect; (ii) significant (P<0.05) **GCA** for KGR and GFD, and significant **SCA** only for KW; (iii) hybrids overcome (P<0.001) inbreds in **GFD** (1080 vs 1020 °Cd) and **KW** (266 vs 232 mg kernel$^{-1}$), therefore achieving significant **MPH** (P<0.001) only for GFD (6.5%) and KW (15.2%); (iv) Heritability values (**H$^2$**) were high for all traits (Table 2).

**Table 1.** Analysis of variance for kernel weight (KW, mg kernel$^{-1}$), kernel growth rate (KGR, mg°Cd$^{-1}$) and grain filling duration (GFD, °Cd).

| Source of Variation | DF | Mean Square | | |
|---|---|---|---|---|
| | | KW | KGR | GFD |
| Nitrogen (N) | 1 | 241 ns | 0.0001 ns | 1554 ns |
| Genotype (G) | 15 | 2885 *** | 0.0104 *** | 14095 *** |
| Inbred (I) | 3 | 732 ns | 0.03 *** | 35683 *** |
| Hybrid (H) | 11 | 1897 *** | 0.007 *** | 6414 *** |
| I vs H | 1 | 20216 *** | 0.001 ns | 33817 *** |
| GCA | 3 | 1856 ns | 0.047 * | 41809 ** |
| SCA | 6 | 5978 ** | 0.0017 ns | 11211 ns |
| G × N | 15 | 412 ns | 0.0028 * | 3437 ns |

***, **, *, ns. Significant at P<0.001, P<0.01, P<0.05 and no significant, respectively.

**Table 2.** Mean values, mid parental heterosis (MPH) and heritability (H$^2$) for kernel weight (KW), kernel growth rate (KGR) and grain filling duration (GFD).

| Attribute | Mean Value | | MPH (%) | H$^2$ |
|---|---|---|---|---|
| | Inbreds | Hybrids | | |
| **KW** (mg kernel$^{-1}$) | 232 | 266 | 15.23 ** | 0.84 |
| **KGR** (mg° Cd$^{-1}$) | 0.34 | 0.34 | 1.70 ns | 0.69 |
| **GFD** (°Cd) | 1020 | 1080 | 6.50 ** | 0.74 |

** , ns. P<0.01 and no significant, respectively.

Variation in maximum KW was associated with KGR ($r^2$=0.22, P<0.001) and GFD ($r^2$=0.28, P<0.001) among hybrids, and only with GFD ($r^2$=0.63, P<0.001) among inbreds (Fig. 1a and 1b). A negative association was found between KGR and GFD, which was greater for inbreds ($r^2$= 0.65) than for hybrids ($r^2$= 0.20) (Fig. 1 c).

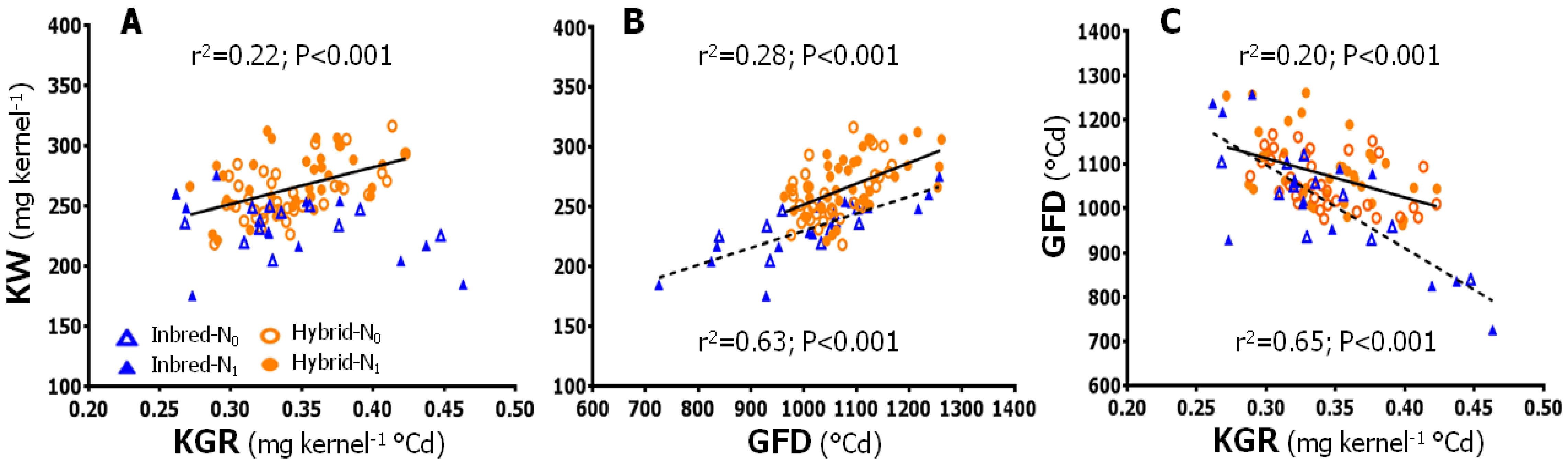


**Figure 1.** Response of kernel weight (KW) to (A) kernel growth rate (KGR), and (B) grain filling duration (GFD). The relationship between KGR and GFD is presented in (C) .

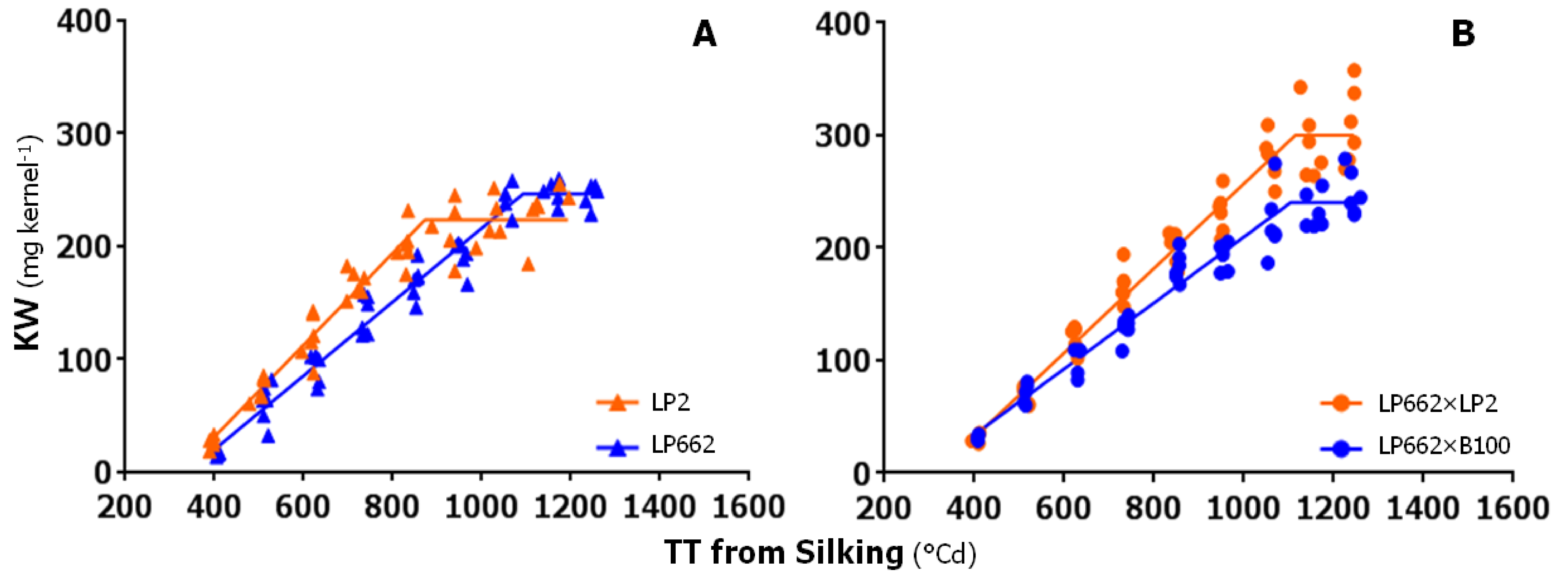


**Figure 2.** Kernel weight (KW) evolution as a function of thermal time (TT) from silking for inbreds (A) and hybrids (B) with contrasting maximum KW.

Inbred **LP662** had the highest KW (243 mg kernel$^{-1}$) and **LP2** the lowest (219 mg kernel$^{-1}$). In addition, **LP2** had the highest KGR (0.42 mg °Cd$^{-1}$) and the lowest GFD (852 °Cd) (Fig. 2a). This inbred achieved a high positive GCA effect for KGR, whereas **LP662** achieved it for GFD. Both genotypes showed the highest GCA values for KW (Table 3). In contrast, inbred **B100** exhibited the lowest GCA value for KGR and KW (Table 3). Consistently, hybrids **LP662×LP2** and **LP662×B100** showed the highest and the lowest KW, respectively, being mainly different in their KGR (0.38 vs 0.30 mg °Cd$^{-1}$) (Fig. 2b). In turn, **LP662×LP2** had the highest MPH for KW (30.1%) and GFD (15.6%), and one of the highest for KGR (2.6%). In agreement with these findings, **LP662×LP2** achieved the highest SCA for KW (32.2 mg kernel$^{-1}$) and GFD (47.0 °Cd), and one of the highest for KGR (0.008 mg °Cd$^{-1}$).

**Table 3.** General combining ability (GCA) for kernel weight (KW, mg kernel$^{-1}$), kernel growth rate (KGR, mg° Cd$^{-1}$) and grain filling duration (GFD, °Cd) of evaluated parental inbreds.

| Genotype | GCA | | |
|---|---|---|---|
| | KW | KGR | GFD |
| B100 | -8.6 | -0.027 | 6.4 |
| LP2 | 3.1 | 0.044 | -43.3 |
| LP662 | 5.6 | 0.000 | 21.6 |
| ZN6 | -0.16 | -0.017 | 15.3 |

## CONCLUSIONS

**In this work we characterized the genotypic variability of the physiological determinants of KW in a set of contrasting inbreds and their hybrids. Results showed a strong compensation between KGR and GFD among evaluated inbreds, which was weak among hybrids. All traits exhibited high H$^2$. A significant additive genetic control was found for KGR and GFD, but not for KW. Accordingly, the hybrid with highest KW came from a parental inbred with high KGR and another one with high GFD (both contrasting in KW). Therefore, selection based on these attributes would be more efficient than selection based exclusively on KW.**

**References:**
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