Coefficients for Modelling the Respiratory Carbon Loss of Field-Grown Maize

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1-Introduction

Approximately 50% of the carbon fixed by a maize crop is lost again to respiration, but respiratory carbon losses are poorly understood, especially in a field environment. Development of robust mechanistic maize growth models requires a realistic parameterization of respiration in the field. The objective of this study was to estimate crop respiratory carbon loss from measurements of single plant respiratory carbon efflux, crop growth rate and crop dry matter.

2-Materials and Methods

The experiment was conducted at the University of Guelph Elora Research Station in Ponsonby ON, Canada in 2012.

- A combination of genotypes and densities were used to create variation in plant dry matter:

Genotypes: CG 102; CG 108 and
F1 Hybrid (CG102xCG108)

Densities: 8 pl m^{-2} and 16 pl m^{-2}

- On seven dates crop dry matter (DM) and Minimum Daily Respiration ($R_{md,}$ the shoot respiration rate at the end of the dark period) were measured.

Dates:

4 and 2 weeks pre silking (-4W and -2W)

Silking

2, 4, 6, and 10 weeks post silking (+2W, +4W, +6W and +10W)

- A multiple linear model was fitted between R_{md} and DM and CGR, to predict the R_{md} on every day of the season.

Model $\mathbf{R_{md} = \alpha DM + \beta CGR}$

Were **α** and **β** are the coefficients determined by regression. DM is the dry matter on a given day and CGR is the crop growth rate on the same day.

4-Conclusion

- R_{md} had a linear relationship with DM on a single day and the slope of this relationship decreased over the course of the season.
- R_{md} could be be estimated as 1% of the DM and 20% of the CGR.
- The accumulated R_{md} at physiological maturity was estimated to be 71% of the accumulated DM in the hybrid.

3-Results

- Plant $\mathbf{R_{md}}$, expressed in nmol CO2 pl^{-1} s^{-1} had a linear relationship with plant dry matter (g pl^{-1}) (Figure 1). The slope of the relationship decreased over the course of the season. Plants were uprooted the evening before respiration measurements were made, then stored in darkness in the lab overnight. Respiration and dry matter data are for shoots only.

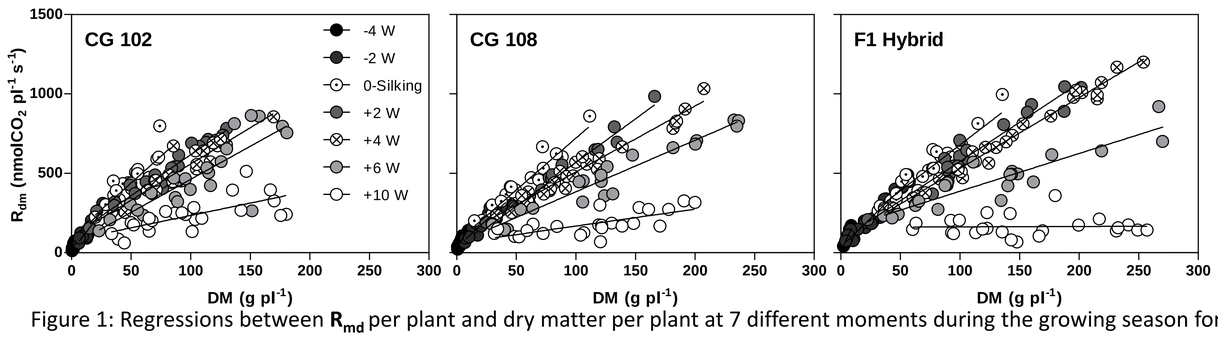

Figure 1: Regressions between $\mathbf{R_{md}}$ per plant and dry matter per plant at 7 different moments during the growing season for the inbred lines CG 102 and CG 108, and their F1 Hybrid. Lines indicate best fit linear regressions on each date.

- Crop R_{md} on a ground area basis could be estimated over the entire season using a single function that incorporated the current CGR and the current crop DM. The R_{md} can be estimated on each day as a 1%(0.86% – 1.22%) of the current DM and 20% (17.97% to 22.34%) of the current crop growth rate (Figure 2).

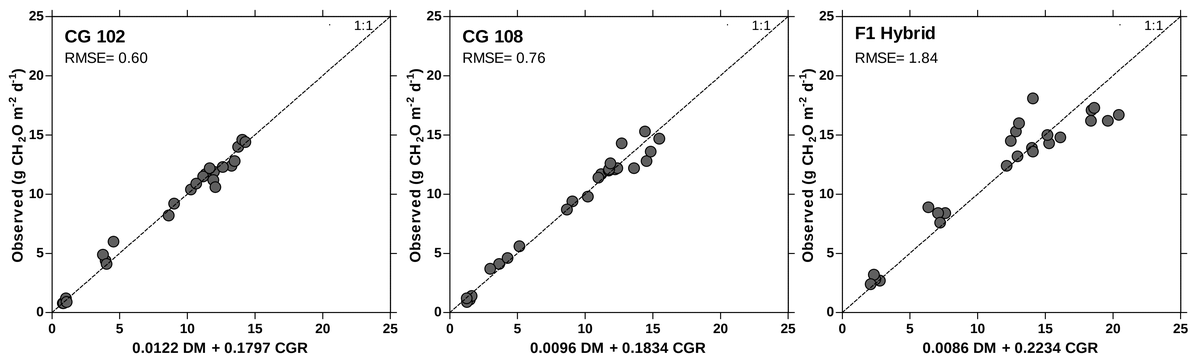

Figure 2: Observed $\mathbf{R_{md}}$ vs respiration predicted by the model presented in this poster for the inbreds CG 102 and CG 108 and their F1 Hybrid. The root mean square error (g CH_2O m^{-2} d^{-1}) is shown in each graph. On the X axis the model to predict R_{md} is shown. Respiration was expressed as g CH_2O assuming that dry matter has a carbon content of 40%.

- Maximum crop growth rate occurred close to flowering, but respiration peaked two weeks after flowering. At physiological maturity (PM) the cumulative dry matter loss attributable to R_{md} was estimated to be 88%, 72% and 71% of the accumulated biomass of CG 102, CG 108 and their F1 hybrid respectively (Figure 3).

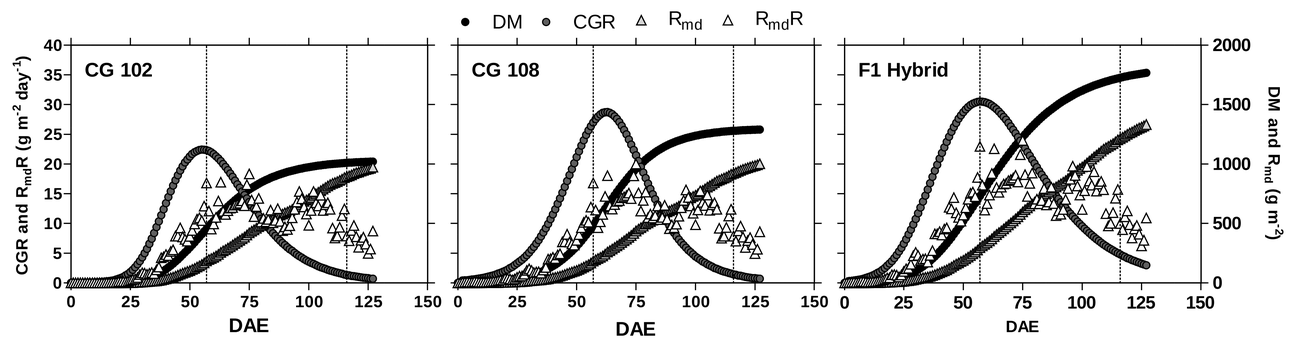

Figure 3: Accumulated dry matter (DM) and accumulated respiration (R_{md}) are expressed in g m^{-2} on the right axis. Crop growth rate (CGR) and respiration rate ($R_{md}R$) are expressed in g m^{-2} day^{-1} on the left axis.