Potential maize yields in a Mediterranean environment depend on conditions around flowering

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Introduction

Understanding the effects of different combinations of sowing dates and cultivars on maize yield is essential to develop appropriate climate change adaptation strategies. Thus, modelling ability in reproducing the observed response of maize yield to sowing dates and cultivars needs to be assessed. In particular, whether crop conditions around flowering can entirely explain the variability of potential yields across sowing dates and cultivars in climatic conditions such as the Mediterranean ones (where high temperatures may occur during the grain filling period) needs to be explored. Otherwise, also assimilation during grain filling and its duration should be taken into account.

Materials and Methods

Here we test in potential conditions the WOFOST model, based on the partitioning approach, and a simpler model, based on physiological crop conditions around flowering, built combining WOFOST-simulated above-ground biomass, LAI, anthesis date with the yield estimation method proposed by Otegui et al. (1998) and Gambín et al. (2006), hereafter Otegui-Gambín. The latter calculates kernel number on the base of the amount of intercepted photosynthetically active radiation during the critical period of ear elongation, i.e. around flowering, and kernel weight on the assimilate availability close to flowering, which includes the period of early grain development. Models evaluation was based on a 2-year field experiment conducted in a Mediterranean environment under fully irrigated conditions.

Results and Discussion

Both modelling approaches reveal good performance in simulating average maize yield under irrigated conditions. However, the simpler one based on the conditions around flowering outperforms the WOFOST model in the responsiveness to changes in sowing date and cultivar, with a RMSD (root mean square difference) reduction and a higher model efficiency (Willmott, 1982). The yield variability across the six sowing dates, calculated using the variation coefficient *per* year and cultivar, was higher in the Otegui-Gambín approach than in WOFOST, as shown in Figure 1.

Our analyses reveals that crop conditions around flowering time can explain alone maize yield variation through different sowing dates and cultivars under irrigated conditions. This is because in an environment where crop can fully take advantage of the growing season, in absence of environmental constraints, such as water shortage, frost or heat stress, yield is solely determined by radiation and temperature during the yield critical period (Andrade et al., 2010) Thus, higher temperatures during grain filling may change grain filling duration but not necessarily yields if they are compensated by high incident daily radiation supporting the findings of Muchow (1990). Therefore, the variation in duration of the grain filling, the main yield determinant in the partitioning modelling approach, may produce a simulated yield variability that is different from the one determined by biomass production and intercepted radiation around flowering.

Conclusions

Our findings show that the partitioning approach achieves less accurate estimates of yields across different sowing dates, whereas an approach mainly based on anthesis conditions performs better.

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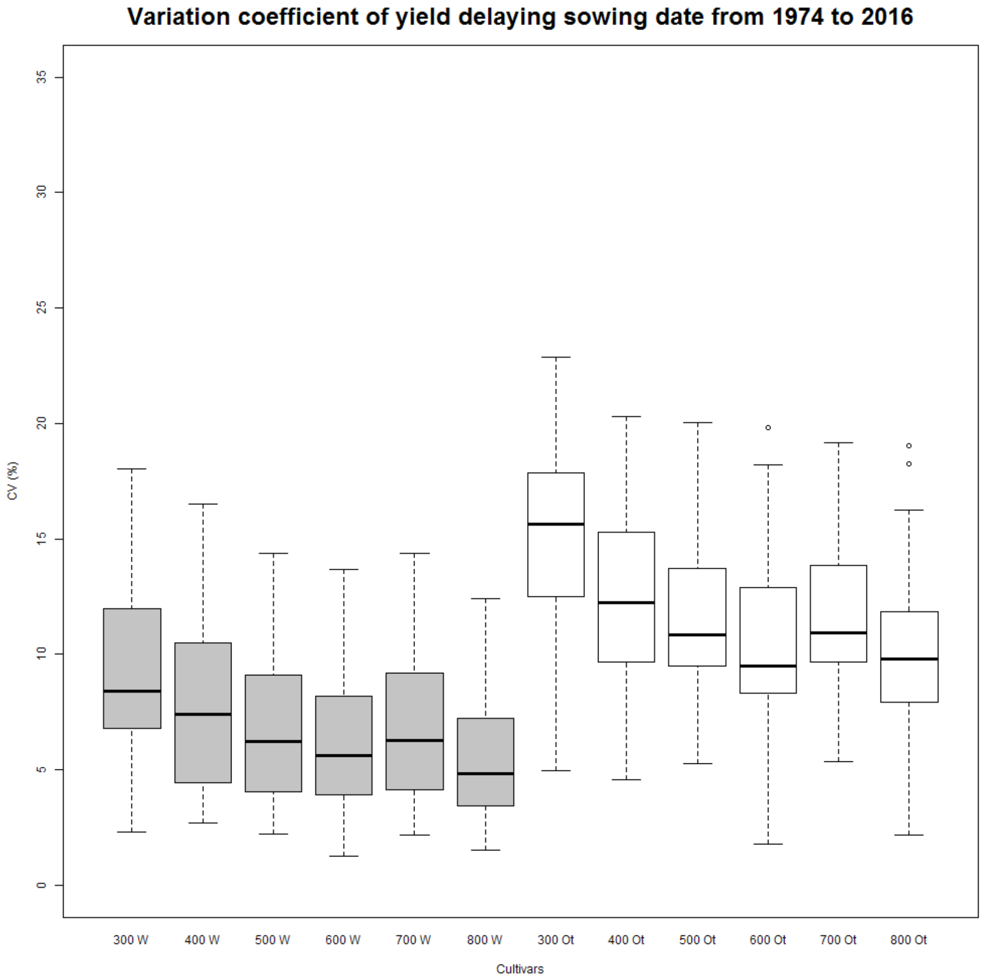

Figure 1. Variation coefficients of predicted maize yields through six different sowing dates (15th and 30th of each month from April to June) for each cultivar type (300, 400, 500, 600, 700, 800) during the 1974-2016 period. Grey and white boxplots correspond to the variation coefficients of the yields simulated by WOFOST (W) and Otegui- Gambín (Ot), respectively.

Keywords: sowing date, cultivar, maize, modelling, potential grain yield variability.

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