Winter wheat development and growth in The Netherlands: Using a detailed field trial to update crop parameters in WOFOST

Joao Silva, A.J.W. de Wit, B. Rijk, I. Supit, Pytrik Reidsma, M.K. van Ittersum

Winter wheat development and growth in The Netherlands: Using a detailed field trial to update crop parameters in WOFOST

Silva Joao V.[1] (joao.silva@wur.nl), de Wit A.J.W.[2], Rijk B.[3], Supit I.[4], Reidsma P.[3], van Ittersum M.K.[3]

[1] *Centre for Crop Systems Analysis, Wageningen University, Wageningen, The Netherlands*; [2] *Earth Obs. and Environmental Informatics, Wageningen Environmental Research, Wageningen, The Ne*; [3] *Plant Production Systems, Wageningen University, Wageningen, The Netherlands*; [4] *Water Systems and Global Change, Wageningen University, Wageningen, The Netherlands*

Introduction

Crop models are key tools for agricultural research (van Ittersum et al., 2003). Despite the wide range of model applications, little attention has been paid to model calibration (Seidel et al., 2018). Detailed field trials are needed for this purpose but these are costly and barely conducted, and thus model parameters tend to become outdated. This study aims to present the results of field trials conducted in The Netherlands alongside a re-parametrization of WOFOST for relatively old and new wheat varieties. We deem this important given the genetic yield progress of wheat in The Netherlands (Rijk et al., 2013).

Materials and Methods

Two field trials were conducted in Wageningen to estimate the potential yield of winter wheat. The first was harvested in the summer 2014 and the second in 2015. The trials included three varieties (one old variety 'Ritmo' (released in 1992) and two recent varieties 'Tabasco' (2009) and 'Julius' (2010)) and three N levels (180, 240 and 300 kg N/ha) laid out in a split-plot design in four replicates. Ten intermediate samples were taken during the growing season to measure leaf area index (LAI), aboveground biomass of leaf (LVB), stem (STB) and grain (GRB) and yield components. Crop development was also recorded, including anthesis and maturity dates .

Data from 2014 were used for model calibration and from 2015 for model evaluation. Calibration consisted of: 1) optimization of thermal times to anthesis and maturity using observed phenological dates, 2) optimization of six parameters controlling leaf and biomass dynamics using measured LAI and total aboveground biomass (TAGP) and, 3) manual calibration of partitioning coefficients to approximate final yield. A non-linear optimization algorithm minimizing the RMSE between simulated and observed data was used for calibration. Simulations were done with WOFOST (de Wit et al., 2018), which was modified to include reallocation of leaf and stem biomass to grain after anthesis.

Results

Measured yields were between 10.31 and 12.52 t DM/ha in 2014 and between 10.53 and 13.06 t DM/ha in 2015. Wheat yields increased with N level and these effects were significant across years and varieties. In 2014, there were no significant yield differences between Julius and Tabasco and both outperformed Ritmo. In 2015, Tabasco obtained the greatest yield followed by Ritmo and Julius with differences between varieties being statistically significant.

WOFOST reproduced the observations of development stage, TAGP, LAI, LVB, STB and grain yield fairly well for the old variety (Figure 1). This was particularly true prior to anthesis (DVS value of 1) but values of TAGP and grain yield were slightly underestimated towards the end of the season. First results indicate that crop parameters and model performance for the new varieties were similar to those reported here for the old variety, but detailed results will be presented.

Conclusion

Detailed field trials under potential growth conditions are needed for proper calibration of crop models. This study builds upon these to re-parametrize WOFOST for winter wheat in The Netherlands. Preliminary results indicate the model can reproduce the measured data fairly well and that there are no major differences in crop parameters between the old and new varieties. Next steps will focus on improving model calibration regarding partitioning coefficients and on documenting differences in crop parameters between old and recent wheat varieties.

…/…

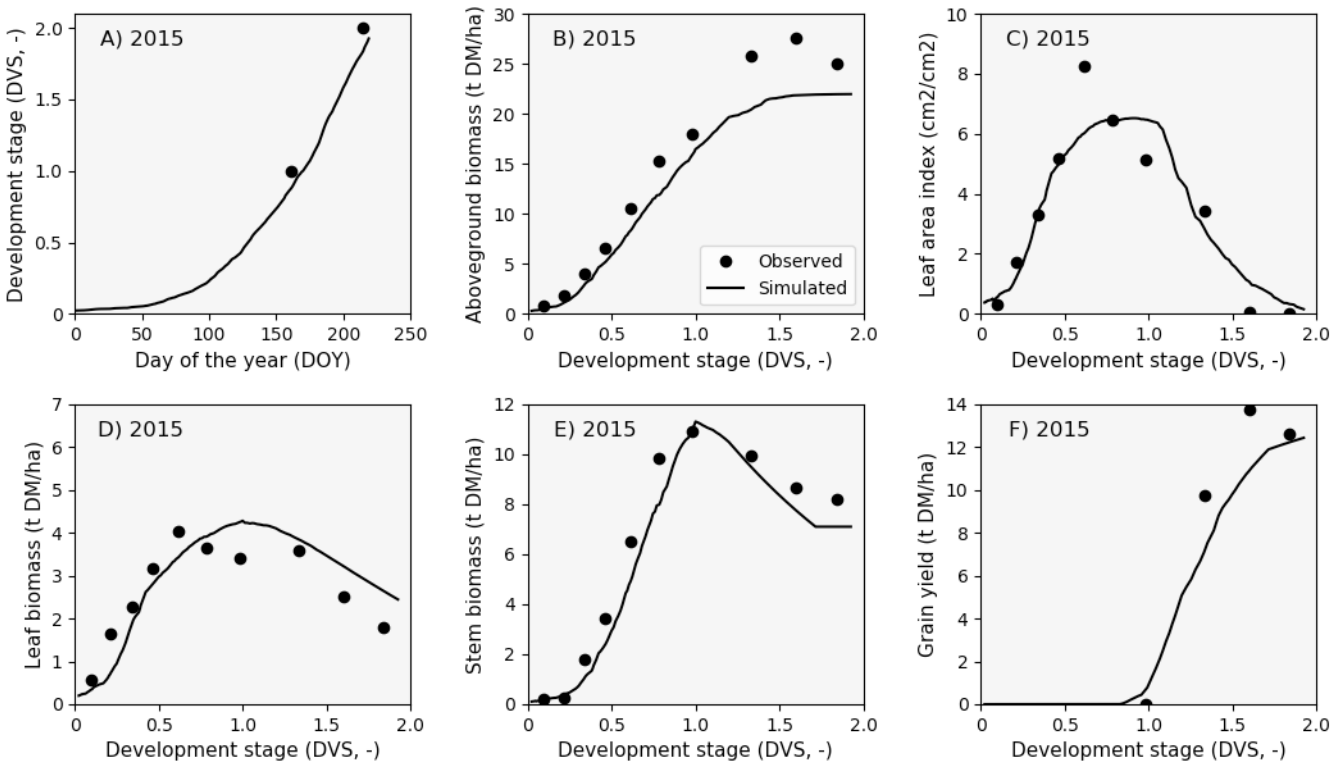

Figure 1. Simulated and observed data on A) development stage, B) aboveground biomass, C) leaf area index, D) leaf biomass, E) stem biomass and F) grain yield for an old winter wheat variety 'Ritmo' with 300 kg N ha-1 in year 2015 (used for model evaluation only).

Keywords: Yield potential, Model calibration, Wheat varieties, Genetic progress.

References:

1. de Wit, A., Boogaard, H., Fumagalli, D., Janssen, S., Knapen, R., van Kraalingen, D., Supit, I., van der Wijngaart, R., van Diepen, K. (2018). 25 years of the WOFOST cropping systems model. Agricultural Systems, 168: 154 – 167.
2. Seidel, S., Palosuo, T., Thornburn, P., Wallach, D. (2018). Towards improved calibration of crop models – Where are we now and where should we go? European Journal of Agronomy, 94: 25 – 35.
3. Rijk, B., van Ittersum, M.K., Withagen, J. (2013) Genetic progress in Dutch crop yields. Field Crops Research, 149: 262 – 268.
4. van Ittersum, M., Leffelaar, P., van Keulen, H., Kropff, M., Bastiaans, L., Goudriaan, J. (2003). On approaches and applications of the Wageningen crop models. European Journal of Agronomy, 18: 201 – 234.