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"Solidarity in a competing world — fair use of resources"

Suitability of Simulation Models for Crop Growth and Development in West African Sudan Savannah

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Abstract

Increased food security and livelihoods in West African Sudan Savannah can be gained through sustainable cropping systems. In the region, rain-fed agriculture remains the dominant source of food production systems, typified as deficient in organic matter, nitrogen, and phosphorus. Changing climate and agricultural land use dynamics challenge the future of these systems because warming will alter nutrient use efficiency. Quantification of nitrogen and phosphorus dynamics versus crop responses within production systems are in its infancy, but could make a major step forward towards sustainable intensification when using suitable deterministic models. Obviously, crop models needs to be parameterised and validated before a systematic use can be envisaged. This study examined how and to what extent CERES-Maize and Sorghum, CROPGRO-Cotton and Cowpea models of DSSAT v4.6 package can capture crop growth and development in the Sudan Savannah agro-ecological zone of Benin. The models were parameterised and calibrated with data set of researcher-managed field trials carried out under non limited nutrient and water-stress conditions on Gleyic Alisols in 2014. The calibrated models were validated with data set of 2015. The models simulated accurately anthesis and maturity with normalised root mean square error (nRMSE) of 1–15 % for *Zea mays*, *Sorghum bicolor*, *Vigna anguiculata* and *Gossypium hirsutum*. The CERES-Maize simulated final grain yields with nRMSE of 7 % while CERES-Sorghum reproduced the yields with nRMSE of 21 %. The CROPGRO-Cowpea and Cotton predicted the grain yields with nRMSE of 36 % and 13 % respectively. The nRMSE between observed and simulated final biomass were 3–17 % in CERES and CROPGRO. The CERES-Maize reproduced the time series above ground biomass (AGB) with a Modelling efficiency (EF) of 0.93 and Index of agreement (d) of 0.98. The CERES-Sorghum showed a goodness of fit, evidenced by EF of 0.92 and d of 0.98. The CROPGRO accurately represented the AGB with EF of 0.60–0.95 and d of 0.91–0.99. The CERES and CROPGRO models accurately predicted crops components within the acceptable thresholds of the lowest nRMSE, EF $\geq$0 and d $\geq$0.75. These models could be used for further assessment of their capability in simulating N and P dynamics in soil-plant systems.

Keywords: CERES and CROPGRO models, crop growth and yields, models validation, production systems

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