Modelling the agronomic performance of millet-cowpea intercropping under the semi-arid environment of Senegal

Yolande SENGHOR[1,2,3], François AFFHOLDER[3], George Anicet Manga[1], Mbaye Diop[2], Alpha Bocar BALDE[4]*

[1]Université Gon Bergers, Saint-Louis, Sénéga ; [2] Institut Sénégalais de Recherches Agricoles, Dakar , Sénégal ; [3]CIRAD, AIDA, Montpelier, France ; [4]SODAGRI, Dakar, Sénégal

Keywords : Cropping system, pearl millet, cowpea, model, performance, variability

Introduction

In the Sahel, particularity in Senegal, pearl millet ([*Pennisetum glaucum* (L.) R. Br.], is one of the major cereals constituting the bases of the population's subsistence. However, its production faces several constraints leading to extreleley low yields (Affholder et al., 2013), including the low nutrient content of the soil, especially nitrogen (Badiane, 1993). Added to this is the high inter-annual variability of climate, the high cost of inputs and the low an inter_annually variable price of grain making conventional crop intensification risky and poorly profitable economically. The intercropping pearl millet with cowpea is expected to promote better management of arable land thanks to a land equivalent ratio (LER) greater than 1, i.e. the by improving the yield of the associated crops as compared to sum of the yields of sole crops using the same amount of land (Obulbiga et al., 2015). Given the complexity of the variability of the responses of these intercrop depending on the soil and climate contexts, the use of modeling is a less costly and less time-consuming method than experimentation, which makes it possible to understand how the intercrop works and to test scenarios of the intercrop in order to improve its functioning. A fundamental aim of the experiment was to simulate different scenarios in the context of climate change in order to obtain optimal production of pearl millet while improving the physico-chemical conditions of the soil through the use of different sources of nitrogen (chemical fertilizers, intercropping system and mulching). Specifically, this involves studying the effect of fertilization, mulching and association (and density of cowpea seedlings) on the development and yield of pearl millet and cowpeas; to assess the effect of the combination of different nitrogen sources on soil physicochemical properties and crop yields; to study the agronomic performance (LER) of the intercropping pearl millet-cowpea and its inter annual variation according to the combination of the different nitrogen sources and at the end of calibration, validate the StiCs model. This is a work of which only the experimental part is today completed and in this communication we only present the methodology of our project and the very first data analyzes that we were able to carry out with the StiCs model.

Material and methods :

The trial was conducted at the National Center for Agronomic Research of Bambey, Senegal, during the wintering 2018 and 2019. The experiment was set-up as a complete random block design with a factorial structure in strictly rainy conditions and with additional irrigation.

The factors studied were fertilization, cropping system, sowing density and mulching. Pearl millet, souna 3, cowpea, Baye Ngagne and 58-74f were used. The data from these experiments will be used to calibrate the StiCs model first, also using the literature to configure the characteristics of the species in our study. Then we will evaluate the model by comparing the observed dynamics to those simulated so as to verify what gives us the model, to understand and predict the dynamics and finally perform virtual simulations in a context of climate variability, in order to evaluate the performance of these systems in the future.

First results

The literature review and the data from the 2018 experiments allowed a first calibration of the thermal constants of the Stics model to reproduce the phenology and LAI of cowpea and millet in pure culture.

Conclusion and continuation of the work: The data obtained during these two years will allow us to assess the agronomic performance of the associated mil-cowpea crops in different contrasting fertilization situations and to calibrate the model.

References

Affholder, F., Poeydebat, C., Corbeels, M., Scopel, E., Tittonell, P., 2013. The yield gap of major food crops in family agriculture in the tropics: Assessment and analysis through field surveys and modelling. Field Crops Res. 143, 106-118.

Aminata Niane Badiane, 1993. The organic status of sandy soil in the Center-North area of Senegal, Agricultural sciences, National Polytechnic Institute of Lorraine, pp.224.

Obulbiga M.F., Bougouma V. and Sanon H.O. 2015. Improvement of the forage supply by the dual-use cereal-legume crop association in the northern Sudanian zone of Burkina Faso. *International Journal of Biological and Chimical Sciences*, vol. 9, n°3,1431-1439.