CAN GENOTYPE X ENVIRONMENT MANAGEMENT INTERACTIONS (GEMI) BE PREDICTED IN SUNFLOWER MULTI-ENVIRONMENT TRIAL?

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ABSTRACT

Climate change and input reduction in agriculture lead to a diversification of cropping environments with a higher expression of biotic and abiotic stresses. In this context, adapting the choice of cultivars according to their cropping environment is of special importance to increase sunflower productivity. Crop cultivar assessment programs aim at evaluating the performance of new cultivars in multi-environment trials (MET). These are a series of field trials conducted across a range of geographic locations and sometimes over several years. However, choosing a cultivar according to its global performance can be risky because of GEMI, which induce significant variations in the relative performance of cultivars when they are assessed in different environments and submitted to various crop management practices. The analysis of GEMIs could enrich the current information on commercial cultivars, and therefore improve the recommendations on cultivar according to the farmers cropping environment. This study aimed at evaluating the predictive value of statistical methods that model GEMI on cultivar MET. Those methods use environmental covariates quantifying major abiotic stresses. Two approaches were evaluated: the model is performed either directly on the yield variable or on the interaction terms first estimated by a mixed model. For both approaches, several methods are evaluated: factorial regression, PLS regressions, Random Forest and Lasso regression. These models are assessed on a "virtual dataset" generated by SUNFLO, a dynamic model simulating genotype-specific performance of a sunflower crop in contrasted environments. The predictive quality of the statistic models was assessed by cross-validation and their predictive values were compared to the one of an additive model in which GEMI is not taken into account. Then a diagnosis of error of prediction was performed to identify which kind of environment is more difficult to predict. The results obtained showed that the best predictive approach is to model directly GEMIs with the Random forest statistical method. However, compared to an additive model, the improvement of the predictive value achieved by modeling GEMI's remains limited. This improvement is all the worst that the stresses generating GEMI are early in the cropping season. This study shows clearly the inadequacy of the classic statistic methods to model the GEMI in the MET even in an optimistic context (data generated without error on the yield and the environmental covariates).

Key Words : Genotype-environment-management interactions (GEMIs), multi-environment trials (MET), Sunflo