Model-assisted evaluation of yield stability in wheat

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Wang Tien-Cheng[1] (tien.wang@gem.uni-hannover.de), Chen Tsu-Wei[1], Stützel Hartmut[1], Casadebaig Pierre[2]

[1] *Leibniz Universität Hannover, Hannover, Germany*; [2] *Institut national de la recherche agron, Castanet-Tolosan, France*

Introduction

Discovering crop variety with stable and high yield performance across different environments is crucial for crop production, especially under the extreme climatic regimes. However, it is difficult to test thousands of genotypes in multiple environments. So we use crop model to analyze the relationships between physiological, phenological and yield-related traits, environmental scenario and stability indices of wheat.

Materials und Methods

APSIM-Wheat model was used to simulate 9100 virtual genotypes grown under 9000 environmental scenarios (4 sites × 125 years, management practices 3 sowing dates × 3 nitrogen fertilization levels and two CO_2 levels, Casadebaig et al., 2016). This dataset was processed by a self-developed R package "toolStability", which calculates 11 stability indices. In order to observe the impact of environments on the stability of trait, stability of a genotype under different environmental scenarios was calculated and normalized for further comparison.

Results and Discussion

Relationship of trait and different stability indices enable the screening of stable and high trait performance indices. Significantly and negatively correlation coefficient was found between genotypic superiority measure index and multiple traits, including flowering time (-0.84), grain number (-0.8), grain protein (-0.98), biomass (- 0.75), and yield (-0.61). Dependency of stability indices on environment was clear across environments. Among them environmental scenarios, "site" and "nitrogen" had the strongest impact on both distributions of trait and stability indices.

Conclusions

Stability index of crop trait depend on the classification of environments. Among all stability indices, genotypic superiority measure was found to be highly and negatively correlated with wheat yield component and yield, which is a potential tool for selecting the high yield and stable genotypes. Variance of stability indices across environmental groups may be used as a novel indicator of the impact of environments on stability of specific trait.

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