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Temperature and radiation stresses explain most of the environmental variation of seed yield across a French network, and allow to tackle GxE interaction in winter oilseed rape cultivars

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A major challenge in plant breeding is to ensure an optimized and stable production under fluctuating environments while reducing the environmental impacts of agriculture. Observed yield limitations correspond both to direct effects of environmental stresses (heat, water availability…) and to genotype by environment (G×E) interactions. This latter term contributed to 10% of the seed yield variation.

The goal of the present work was to characterize the environmental and G×E interaction effects that affect seed yield variations of winter oilseed rape grown over the main cultivation areas in France.

Based on environmental and agronomic variables acquired with two probe genotypes grown over 20 environments, we first defined a set of 84 pedoclimatic indicators that are likely to affect the seed yield. After a Partial Least Square (PLS) Regression analysis, we determined that 10 of these indicators were the most limiting for seed yield. These indicators corresponded to vernalization need, temperature and radiation stress during the reproductive phase. Then, using the PLS results, it was possible to cluster the environments into 5 groups as followings: cluster 1 presenting heat stress during grain filling and low temperature during winter, cluster 2 mimicked the mean network characteristics, cluster 3 presenting high solar radiation during grain filling, cluster 4 presenting optimal vernalization conditions and cluster 5 presenting high temperatures at flowering. In addition, considering clusters into variance decomposition allowed explaining 79% of the environmental effect. Moreover, Genotype × Cluster interactions explained around 30% of the G×E interactions. These results were validated across a wide genetic diversity set including 127 winter oilseed rape accessions.

The strategy consisted in coupling environmental characterization to PLS efficiently to regroup environments while reducing the G×E interactions inside each cluster. These results open prospects for building ideotypes dedicated to each environment category, as well as genetic deconvolution of these specific adaptations/plasticity.