Breeding strategies for more sustainable agricultural production systems (WP2)

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Unpredictable and increasingly variable climatic conditions have highlighted the importance of developing new and innovative strategies for crop breeding and management (Østergård *et al*. 2009). It has become increasingly evident that a better understanding of genotype x environment x management interactions is needed and that sustainable agricultural systems with the ability for self-regulation will be critical in order to reduce inputs, while contributing to soil and water conservation. As environmental and agronomic conditions are heterogeneous between and within locations, diverse crop populations can increase adaptability to the changing and variable range of environments. These challenges, coupled with the additional pressure of loss of plant genetic diversity, has driven novel breeding approaches such as evolutionary breeding using Composite Cross Populations (CCPs) and other genotype mixtures.

The main objective of WP2 in INSUSFAR (INnovative approaches to optimize genetic diversity for SUStainable FARming systems of the future) is to produce breeding material that contributes to more sustainable agricultural production systems. For this, the focus is on the improvement of diverse CCP winter wheat populations developed by the John Innes Centre and the Organic Research Centre in the UK and that have been exposed to variable environmental conditions since 2005, among others at the University of Kassel and the Technical University of Munich. WP2 is divided into three main subtasks, which focus 2.1) on the performance of the CCPs and inbred lines under varying input levels, 2.2) the testing and application of novel breeding approaches to improve CCPs under specific environmental conditions, and 2.3) the determination of diversity of the populations as influenced by environmental conditions.

Task 2.1 will test whether specific adaptation has occurred in the CCPs by testing them under high and low input conditions, as well as under interspecific competition with clover. In addition to the diverse populations, wheat lines that have previously been selected from the CCPs (CCP lines), and commercial varieties, will be tested under the same differential input conditions. In addition, the CCP lines and commercial varieties will be grown under eight levels of nitrogen (N) in order to determine their reaction to N in more detail..

Task 2.2 aims to create two improved CCPs by crossing 50 CCP plants with two sets of three commercial varieties. The improved CCPs will later be tested against the original CCPs to determine the effect of the improvement.

Task 2.3 will analyze the genetic compositions of the CCPs. Testing under different environmental conditions will determine if genetic diversity has been affected by natural selection, and whether the performance and stability can be related to genetic diversity. In addition, heterozygosity will be quantified in order to calculate outcrossing rates. This task will also make use of association mapping, if feasible, using lines from CCPs in order to determine the chromosomal position of morphological traits of interest under differing input environments. In addition, the advantages/disadvantages of marker use for selection in CCPs will be analyzed.

Literature

Østergård, H., Finckh, M. R., Fontaine, L., Goldringer, I., Hoad, S., Kristensen, K., Lammerts van Bueren, E. T., Mascher, F., Munk, L. and Wolfe, M. (2009): Time for a shift in crop production: embracing complexity through diversity at all levels. *Journal of the Science of Food and Agriculture*, 89, 1439-1445.