Genotype vs Environment: the ICARDA durum wheat breeding program for African dryland cultivation

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Durum wheat is a staple and industrial food of many dryland farming systems. ICARDA breeding program has delivered since 1977 germplasm adapted to these farming systems achieving over 150 varieties released in 23 developing countries. The rate of genetic gain in dryland system was assessed in an historical set to reveal an average of +0.9% per year. However, to meet the challenge of climate change and demographic increase, this rate needs to be doubled in the years to come. The novel inclusion of fast cycling and genomic selection in early generations into the breeding scheme will be discussed as ways to reduce recycling time. In addition, the continuous inclusion of novel genetic diversity for target traits remains a key strategy of ICARDA to adapt germplasm to harsh conditions. The identification and validation of markers associated with key loci is also fundamental to deliver germplasm adapted to stresses. For instance, the average water productivity across moisture stressed environments was estimated at 5.1 kg ha^{-1} mm^{-1}, but the inclusion of the positive alleles at three loci on chr. 1B, 2A and 7B generated an average of + 2.2 kg ha^{-1} mm^{-1}. Further, three loci on chr. 3A, 3B and 7B associated to root angle provided +12% yield advantage when field tested under terminal drought stress. Similarly, two loci on chr 1A and 3B resulted in +17% grain yield under severe heat stress tested along the Senegal River. The discovery and inclusion into breeding of these and other alleles will be discussed. Overall, the ICARDA program has integrated the latest genomic and breeding methodologies to double its rate of genetic gain under the harshest climatic conditions, but we continue to need the support of the whole community to continue to do so.