A reverse phenotyping approach identifies physiological differences associated with yield under water stress in leading tomato introgression lines.

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Abstract

Plant productivity in general and under stress, in particular, is a complex and comlitative trait largely influenced by environmental conditions. Among the most important traits are the whole-plant water-balance regulation mechanisms that dynamically change in order to maximize the metabolic activity of the plant. Due to the difficulty of high-throughput phenotyping of these physiological traits (e.g. transpiration, stomatal conductance, and photosynthesis), they are usually measured in static conditions or modeled based on only a few measuring points (low resolution). To overcome this challenge, we utilized a high-throughput gravimetric functional-phenotyping platform (PlantArray) along with a practical reverse phenotyping approach. We selected 30 tomato lines from multiple years of field yield data and functionally phenotyped them for their dynamic response curves using a variety of stress scenarios implemented using drought conditions (each plant received irrigation based on the amount of water it transpired). Our results show that resilient and tolerable traits, in the field, are associated with stomatal plastic conductance, i.e., maximum under well-irrigation, yet the rapid response to changes in environmental conditions (soil and atmospheric). The plastic traits of the idiotype lines were shown to increase water use efficiency (momentarily), thus maximizing yield in water deficit conditions. Based on manual characterizations of the idiotypes, it has been found that their abaxial surfaces have a greater density of stomata and a higher aperture during the early morning. Additionally, these lines showed rapid recovery after a drought. Our study concluded that reverse functional phenotyping can significantly reduce the pre-breading processes for yield-related traits.

Keywords: Functional phenotyping, crops yield, —dynamic response, drought stress, stomatal conductance, reverse phenomics