Successional adaptive strategies revealed by correlating arbuscular mycorrhizal fungal abundance with host plant gene expression

Cheng Gao[1], Pierre-Emmanuel Courty[2], Nelle Varoquaux[1], Benjamin Cole[3], Liliam Montoya[1], Ling Xu[1], Elizabeth Purdom[1], John Vogel[3], Robert Hutmacher[4], Jeffery Dahlberg[5], Devin Colemann-Derr[1], Peggy Lemaux[1], and John Taylor[1]

[1]University of California Berkeley
[2]Agroécologie, AgroSup Dijon, CNRS, Université de Bourgogne, INRAE, Université de Bourgogne Franche-Comté, Dijon, France.
[3]US Department of Energy Joint Genome Institute
[4]University of California West Side Research and Extension Center
[5]University of California Kearney Agricultural Research and Extension Center

June 23, 2021

Abstract

Arbuscular mycorrhizal fungi (AMF), the mutualistic symbionts with most crops, constitute a research system of human-associated fungi whose relative simplicity and synchrony are conducive to experimental ecology. However, little is known about the shifts in adaptive strategies of sorghum associated AMFs where strong AMF succession replaces initially ruderal species with competitive ones and where the strongest plant response to drought is to manage these AMF. First, we hypothesize that, when irrigation is stopped to mimic drought, competitive AMF species should be replaced by AMF species tolerant to drought stress. We then, for the first time, correlate AMF abundance and host plant transcription to test two novel hypotheses about the mechanisms behind the shift from ruderal to competitive AMF. Surprisingly, despite imposing drought stress, we found no stress tolerant AMF. Remarkably, we found strong and differential correlation between the successional shift from ruderal to competitive AMF and sorghum genes whose products (i) produce and release strigolactone signals, (ii) perceive mycorrhizal-lipochitinoligosaccharide (Myc-LCO) signals, (iii) provide plant lipid and sugar to AMF and, (iv) import minerals and water provided by AMF. These novel insights into host gene expression and succession of AMF show adaptive strategies evolved by AMF and their hosts and provide a rationale for selecting AMF to reduce inputs and maximize yield in commercial agriculture. Future research opportunities include testing the specifics and generality of our hypotheses by employing genetically modified host plants, and exploring additional genes underlying the adaptive strategies in natural succession.

Hosted file

`Maintext.plain.2021.05.20.doc` available at https://authorea.com/users/421483/articles/527503-successional-adaptive-strategies-revealed-by-correlating-arbuscular-mycorrhizal-fungal-abundance-with-host-plant-gene-expression