17 June 2020

**Geographic adaptations impact switchgrass resistance to rust infections**

Switchgrass rust is widespread, but findings suggest that it is manageable through genetics.

**The Science**

Disease resistance in plants varies across populations and may be affected by changes in their environment. Researchers at the Great Lakes Bioenergy Research Center (GLBRC) studied one such disease in switchgrass­—rust—to understand the genetic and environmental factors underlying the variation of switchgrass rust resistance. Researchers measured rust severity and conducted quantitative trait locus (QTL) mapping at eight locations across the central U.S. for three consecutive years. Infection severity could not be explained by pathogen species as there were minimal differences in the rust species between different ecotypes and latitudes. Both rust infection severity and morphological differences between switchgrass ecotypes could be explained by two large effect loci, particularly in the northern sites. Thus, rust resistance was dependent on interactions between the switchgrass genetics and environmental factors dependent on latitude.

**The Impact**

Plant disease resistance varies significantly across regions and years. Due to these complexities, accurately measuring the genetic and environmental factors that underlie disease resistance in plants requires large-scale, collaborative studies like this one. Further, these findings suggest that although switchgrass rust is widespread, it is manageable through genetics. This work underlies the challenge of using single gene models for pathogen resistance given the importance of epistatic interaction between candidate loci in shaping the switchgrass rust resistance.

**Summary**

Switchgrass leaf rusts impact switchgrass growth, survival, and yield. The upland switchgrass ecotype has limited resistance to rust pathogens, while the lowland ecotype is more resistant. To understand genotype-by-environment interactions underlying switchgrass rust resistances across the central U.S., GLBRC researchers mapped QTLs for rust resistance and scored leaf rust across 1,500 km of latitude over the course of three years. To identify loci controlling variation in rust infection, a mapping population derived from both upland and lowland plants was used. Rust was present at all sites during the study period but varied in severity over the years. Upland plants experienced more rust severity than lowland plants. *Puccinia novopanici* was the predominant rust species at all field sites, suggesting rust species could not explain the differences in resistance between upland and lowland ecotypes. GLBRC researchers identified two primary QTLs associated with rust resistance over the years. The combination of resistant alleles across these loci was associated with >20% lower rust scores and higher biomass, greater tiller count, and greater height. Two large effect QTLs explained rust severity in the north, but rarely had an effect in the south suggesting that genetic architecture of rust resistance is dependent on the environment. The combination of resistant alleles for both QTLs was stronger than that of either in isolation, suggesting that the epistatic interaction between these loci is essential to their relationship with resistance.

**Contacts**

**Program Manager**

N. Kent Peters  
Program Manager, Office of Biological and Environmental Research  
[kent.peters@science.doe.gov](mailto:kent.peters@science.doe.gov), 301-903-5549

**Corresponding Author**

David Lowry  
Assistant Professor, Michigan State University  
[dlowry@msu.edu](mailto:dlowry@msu.edu), (517) 432-4882

**Funding**

This work was supported by the US Department of Energy grants numbers DE-SC0014156 and DESC0017883. National Science Foundation Plant Genome Research Program Awards grant numbers IOS-0922457 and IOS-1444533, and was supported in part by the Great Lakes Bioenergy Research Center, US Department of Energy, Office of Science, Office of Biological and Environmental Research grant numbers DE-SC0018409 and DE-FC02-07ER64494.

**Publications**

VanWallendael, A. *et al.,* “[Geographic variation in the genetic basis of resistance to leaf rust between locally adapted ecotypes of the biofuel crop switchgrass (Panicum virgatum).](https://www.osti.gov/pages/biblio/1615701-geographic-variation-genetic-basis-resistance-leaf-rust-between-locally-adapted-ecotypes-biofuel-crop-switchgrass-panicum-virgatum)” *New Phytologist* (2020). [DOI: <https://doi.org/10.1111/nph.16555>]

**Related Links**

<https://nph.onlinelibrary.wiley.com/doi/abs/10.1111/nph.16555>