Derailing Witchweed (*Striga*) Virulence in to Achieve Durable and Broad-Spectrum Resistance

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*Striga* resistance in wild sorghum. Sorghum’s resistance to *Striga* field demonstration site.

Alupe, Busia Kenya
Attack of the witch!
Hypothesis
Domestication leads to loss of genetic diversity

Selection cycle 1
Selection cycle 2
Selection cycle 3
Approach
Genomic tools for identification of host resistance and pathogen virulence

01 Wild sorghum
High throughput screening of wild sorghum for Striga resistance

02 Transcriptomics
Differential gene expression for resistance and virulence genes

03 GWAS
Genome wide association mapping for SNP variants
High through-put screening of *Striga* resistance

Striga size, number and biomass

Mbuvi et al., Frontiers in Plant Sciences; 2017
High throughput *Striga* screening facility at KU
Wild sorghum accessions show post-germination Striga resistance

Mbuvi et al., Frontiers in Plant Sciences; 2017
Wild sorghum accessions show post-germination *Striga* resistance

Mbuvi et al., Frontiers in Plant Sciences; 2017
Histological analysis of host parasite interactions
Mechanism of *Striga* resistance in wild sorghum

Susceptible interaction: 9DAI

Resistant interaction: 9DAI

Mbuvi et al., Frontiers in Plant Sciences; 2017
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Grow Striga and sorghum together and extract RNA

Build ILLUMINA TruSeq libraries

Sequence had both host and parasite tissue

Map and separate reads clean up and analyze DE

Two different time points – early parasite development (Stage 3) and late parasite development (Stage 4). 6 wild sorghum and susceptible control

150 nucleotide single end

– approximately 1 x10^9 reads per accession

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More genes differentially expressed in wild sorghum infected with *Striga*
Defense related pathways get up regulated in wild sorghum

- activation of innate immune response
- immune system process
- regulation of immune system process
- response to stress
- defense response
- immune response
- transmembrane receptor protein tyrosine kinase signaling pathway
- plant-type cell wall biogenesis
- beta-glucan biosynthetic process
- response to biotic stimulus
- regulation of cell wall organization or biogenesis
- plant-type secondary cell wall biogenesis
- systemic acquired resistance, salicylic acid mediated signaling pathway
- jasmonic acid mediated signaling pathway
- innate immune response
- regulation of response to stimulus
- cellular response to biotic stimulus

Runo et al 2018 (manuscript in preparation)
More *Striga* genes are differentially expressed in *Striga* infecting wild sorghum.
Cell wall, signaling, defense and transport genes are up regulated

<table>
<thead>
<tr>
<th>GOBP_Term</th>
<th>Fold Enrichm</th>
<th>Bonferroni</th>
<th>Benjamini</th>
<th>FDR</th>
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<tr>
<td>GO:0044092~negative regulation of molecular function</td>
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</tbody>
</table>

Runo et al 2018 (manuscript in preparation)
Cell wall, signaling, defense and transport genes are upregulated.
Derailing the witchweed: Mining for *Striga* effectors
Pipeline for *Striga* effectors identification

- Mapped Reads
  - Signal peptide
  - Cleavage site within 40 amino acids
  - No trans membrane domain out of cleaved site
  - Not targeted to the mitochondria
- Effectors
  - DE at early parasitism stages

Runo et al., (Manuscript in preparation)
The fungal-specific β-glucan-binding lectin FGB1 alters cell-wall composition and suppresses glucan-triggered immunity in plants

Stephan Wawra, Philipp Fesel, Heidi Widmer, Malte Timm, Jürgen Seibel, Lisa Leson, Leona Kesseler, Robin Nostadt, Magdalena Hilbert, Gregor Langen & Alga Zuccaro

β-glucans are well-known modulators of the immune system in mammals but little is known about β-glucan triggered immunity in planta. Here we show by isothermal titration...
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Genome wide association mapping of Striga resistance in a global diversity panel

Kavuluko et al., (Manuscript in preparation)
Genome wide association mapping of *Striga* resistance in a global diversity panel

Kavuluko et al., (Manuscript in preparation)
Diverse resistance *Striga* resistance response in the diversity panel

Kavuluko et al., (Manuscript in preparation)
GWAS identifies of *Striga* resistance in a global diversity panel
GWAS “pinpoints” *Striga* resistance loci

Kavuluko et al., (Manuscript in preparation)
GWAS “pinpoints” Striga resistance loci

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Cystein Synthase
Senescence Specific Cystein Protease
Membrane-associated kinase regulator 2
Clathrin heavy chain 1 (CHC1) gene promoter

Kavuluko et al., (Manuscript in preparation)
GWAS “pinpoints” *Striga* resistance loci

The receptor-like kinase SERK3/BAK1 is a central regulator of innate immunity in plants

Antje Heese*, Dagmar R. Hann†, Selena Gimenez-Ibanez‡, Alexandra M. E. Jones‡, Kai He§, Jia Li§, Julian I. Schroeder.§, Scott C. Peck¶, and John P. Rathjen**

*Department of Biochemistry, University of Missouri, 540G Bond Life Sciences Center, 1201 Rollins Road, Columbia, MO 65211; †The Sainsbury Laboratory, Norwich Research Park, Colney Norwich NR4 7UH, United Kingdom; ‡Department of Botany and Microbiology, University of Oklahoma, Norman, OK 73019; and ¶Division of Biological Sciences, Cell and Developmental Biology, University of California at San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0346

Communicated by David Baulcombe, The Sainsbury Laboratory, Norwich, United Kingdom, June 6, 2007 (received for review May 25, 2007)

Cysteine homeostasis plays an essential role in plant immunity

Consolación Álvarez, M. Ángeles Bermúdez, Luis C. Romero, Cecilia Gotor and Irene García

Instituto de Bioquímica Vegetal y Fotosíntesis, Consejo Superior de Investigaciones Científicas and Universidad de Sevilla, Avda. Américo Vespucio, 49, ES–41092 Sevilla, Spain
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  - Eric Wafula
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- PPGP
  - Zhenzen Yang
- RIKEN
  - Ken Shirasu
- University of Wageningen
  - Harro Bouwmeester
PEER supplement: Enhanced Utilization and conservation of wild sorghum genetic resources

_Striga_ resistance in wild sorghum. Sorghum’s resistance to _Striga_ field demonstration site. Alupe, Busia Kenya