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

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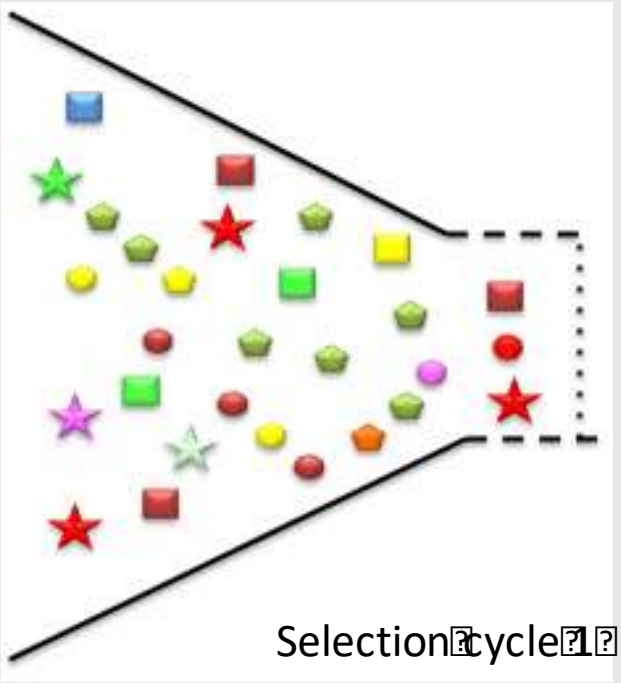
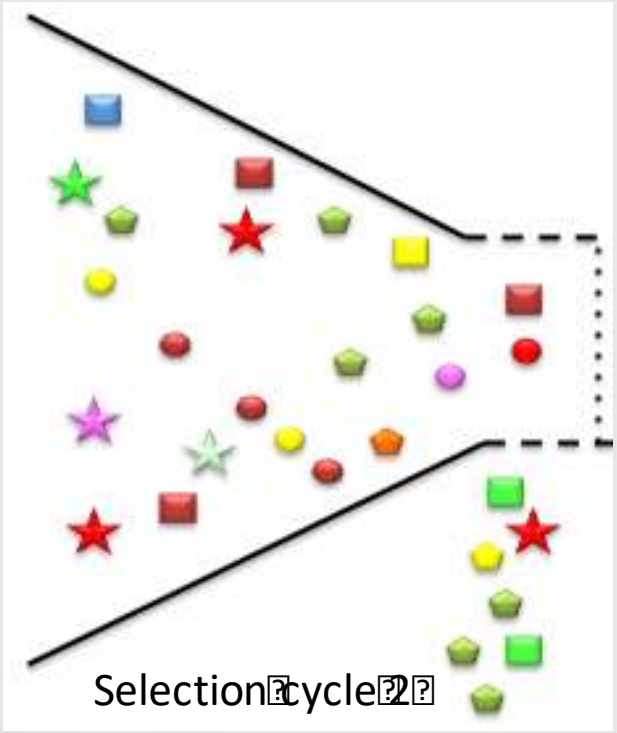
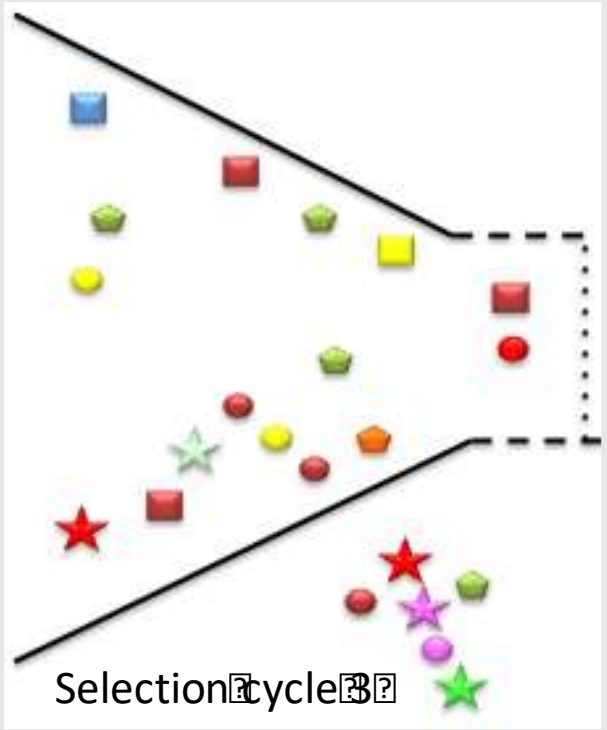
Attack of the witch!

Hypothesis

Domestication leads to loss of genetic diversity







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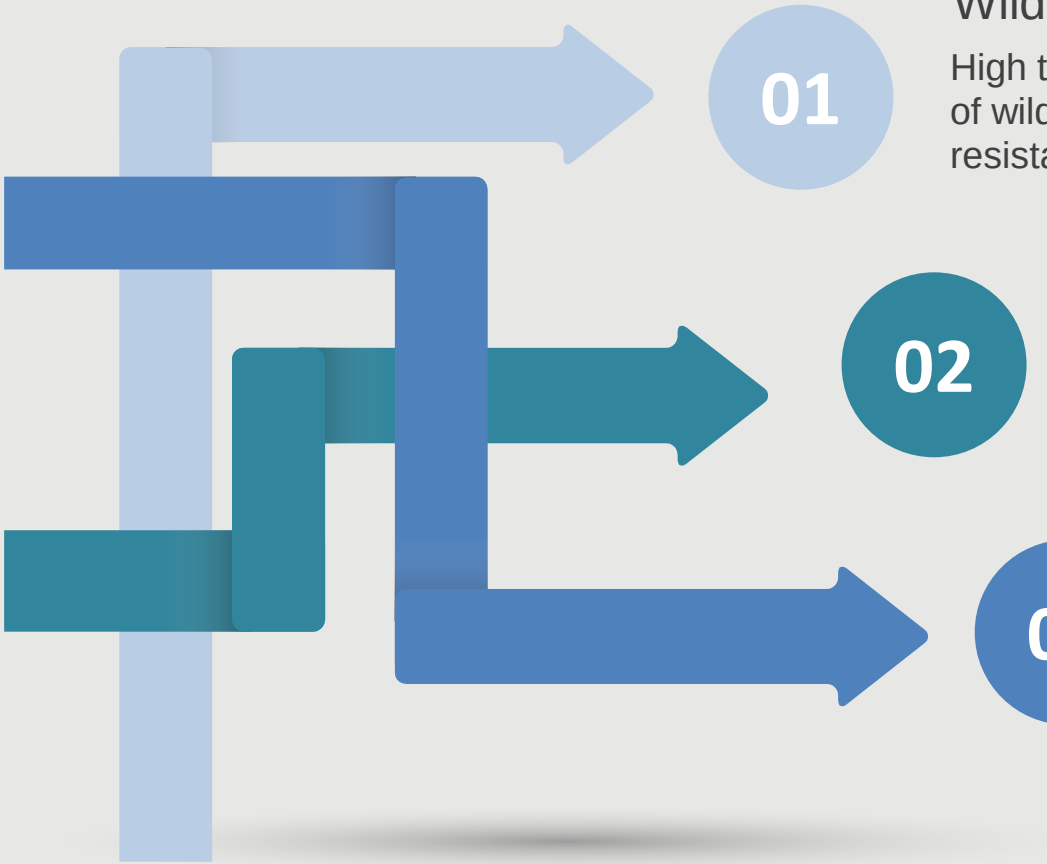
Approach

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

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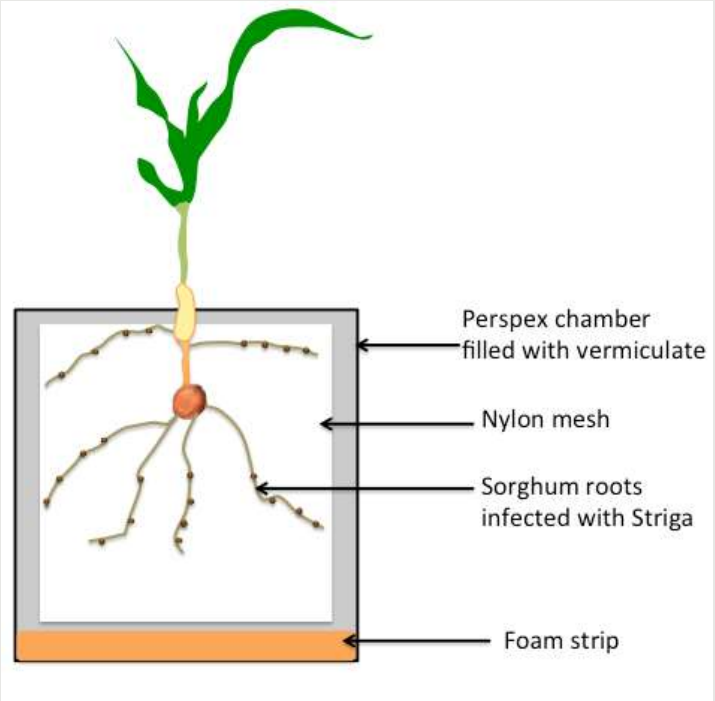
High through-put screening of *Striga* resistance



Striga size, number and biomass

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Mbuvi et al., Frontiers in Plant Sciences; 2017

High throughput *Striga* screening facility at KU

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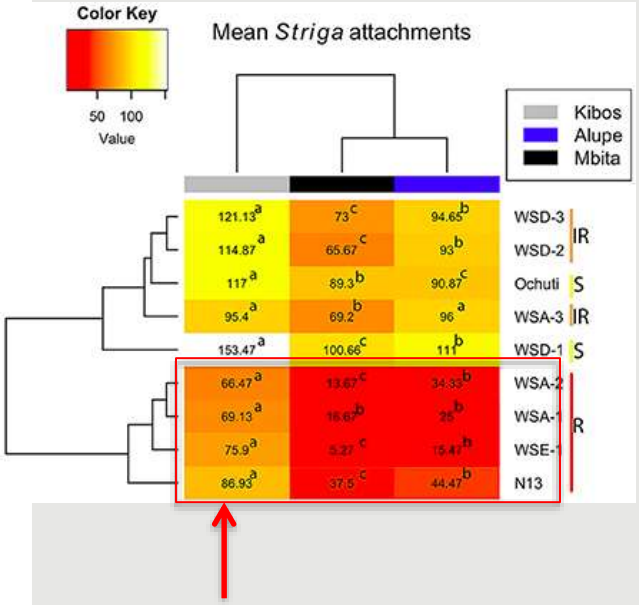
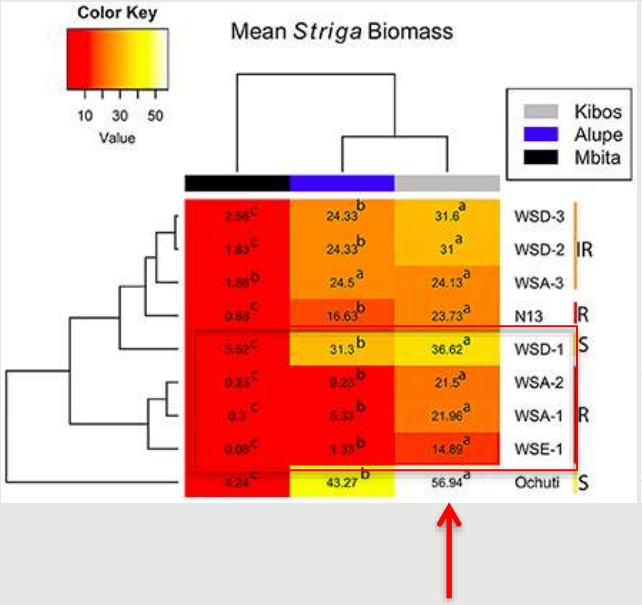
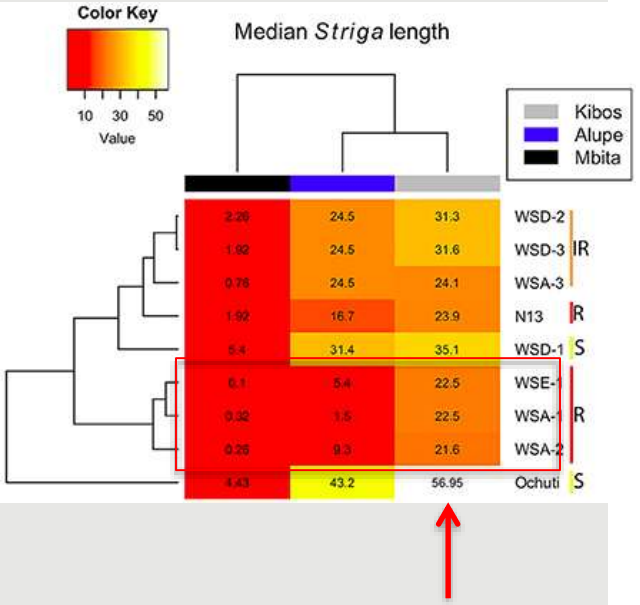
Wild sorghum accessions show post-germination *Striga* resistance







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Mbuvi et al., Frontiers in Plant Sciences; 2017

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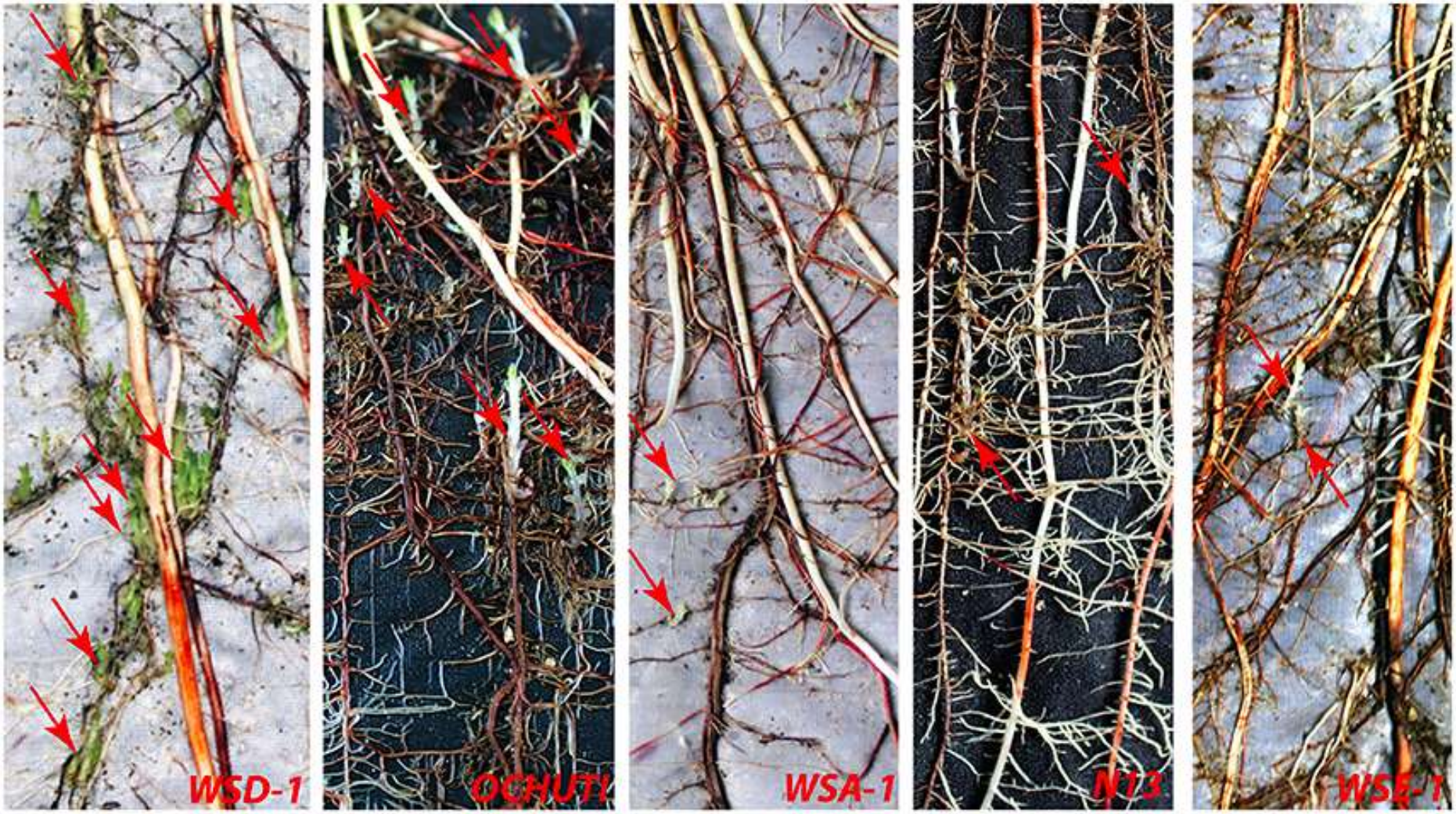

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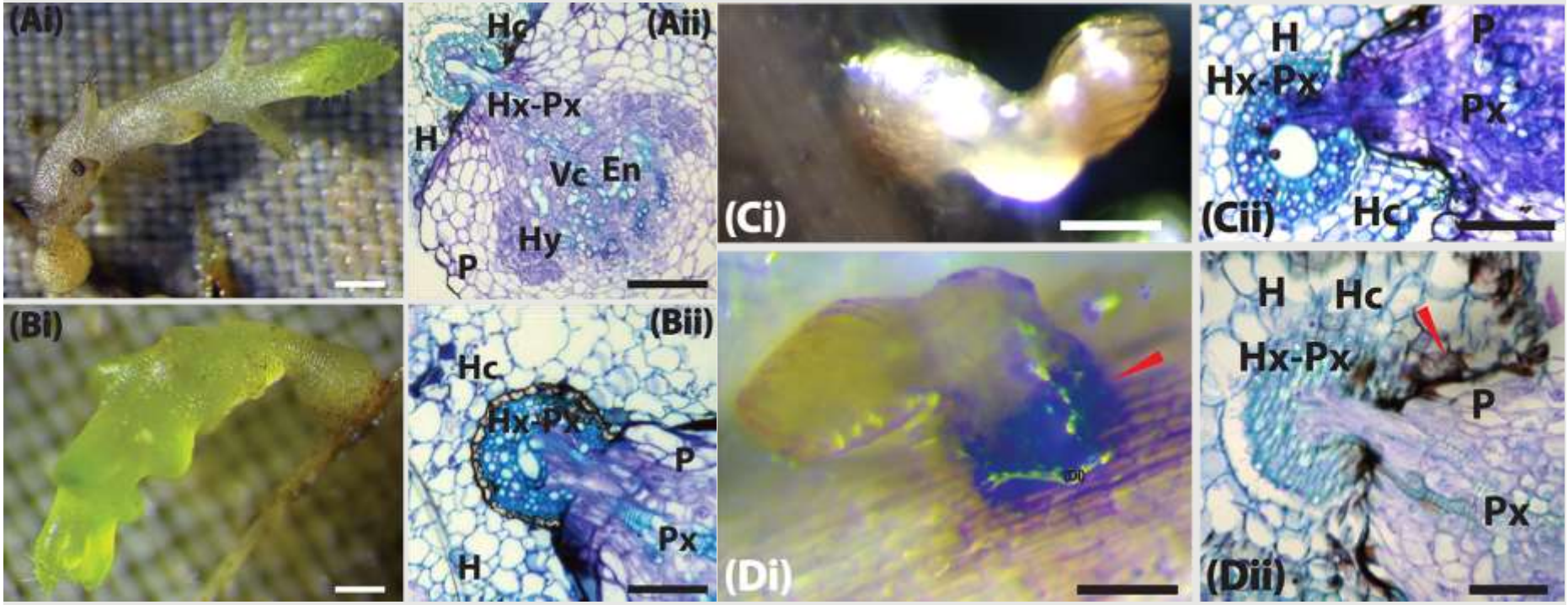
Mbuvi et al., Frontiers in Plant Sciences; 2017

Histological analysis of host parasite interactions

Mechanism of *Striga* resistance in wild sorghum

Susceptible interaction: 9DAI

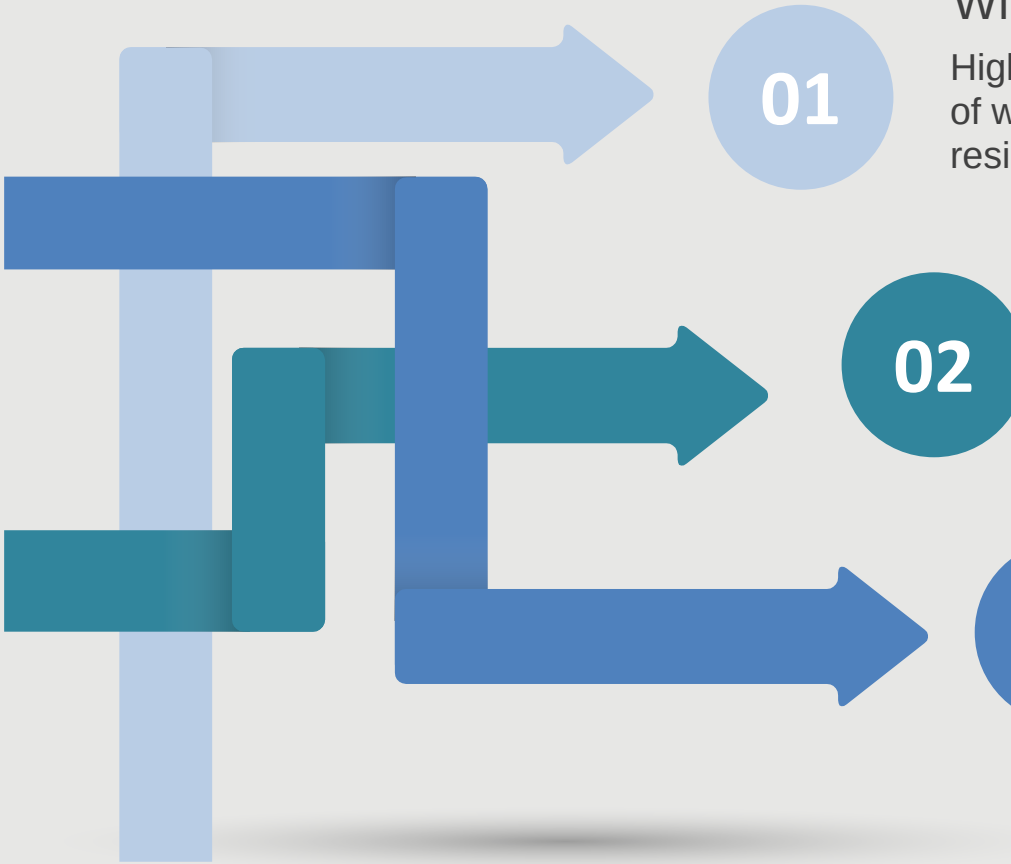
Resistant interaction: 9DAI



Mbuvi et al., Frontiers in Plant Sciences; 2017

Approach

Genomic tools for identification of host resistance and pathogen virulence



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Genomic tools for identification of host resistance and pathogen virulence

Grow Striga and sorghum together and extract RNA

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

Build ILLUMINA TruSeq libraries

150 nucleotide single end

Sequence had both host and parasite tissue

– approximately 1 x10^9 reads per accession

Map and separate reads clean up and analyze DE

– approximately 1 x10^9 reads per accession

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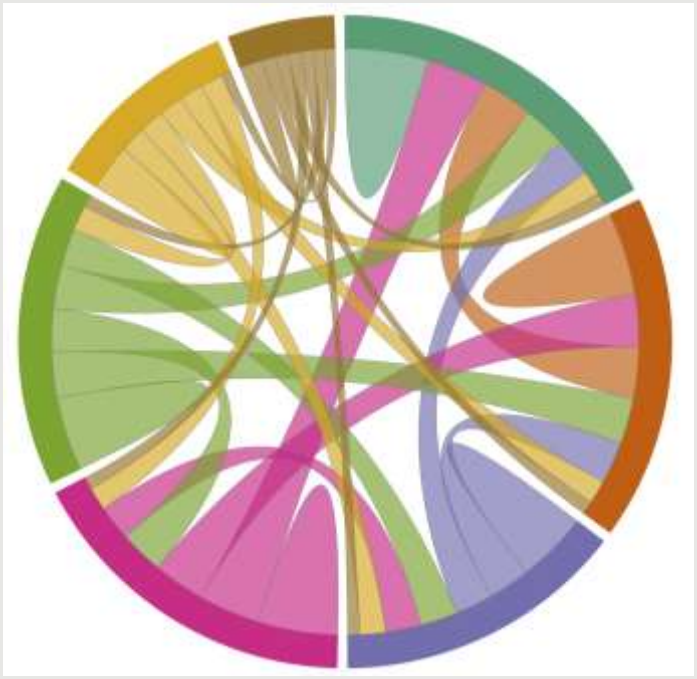
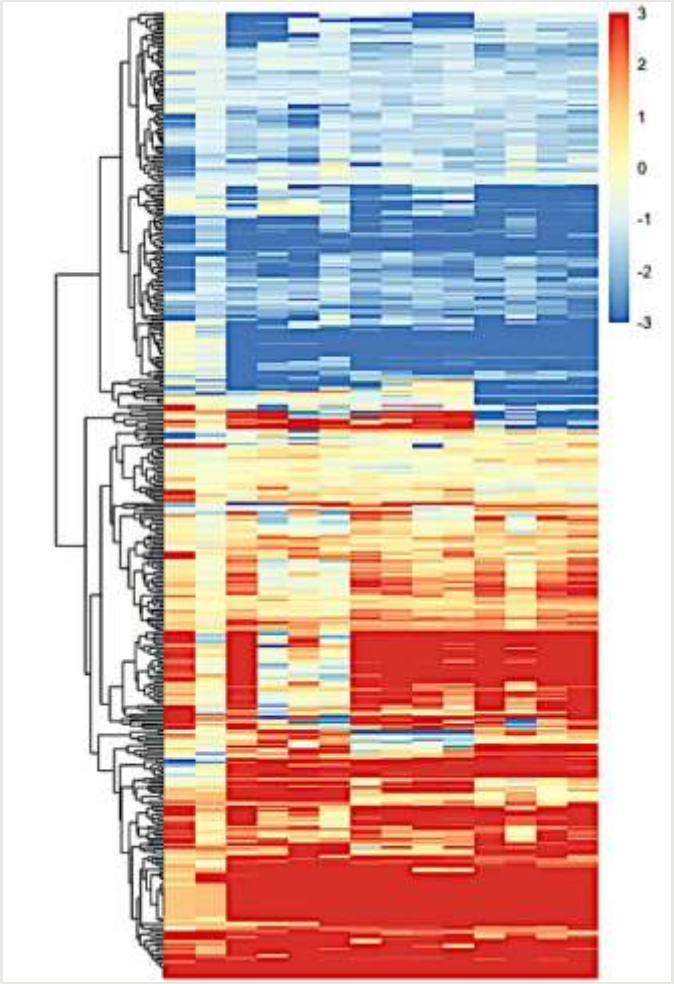
More genes differentially expressed in wild sorghum infected with *Striga*





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Runo et al 2018 (manuscript in preparation)

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

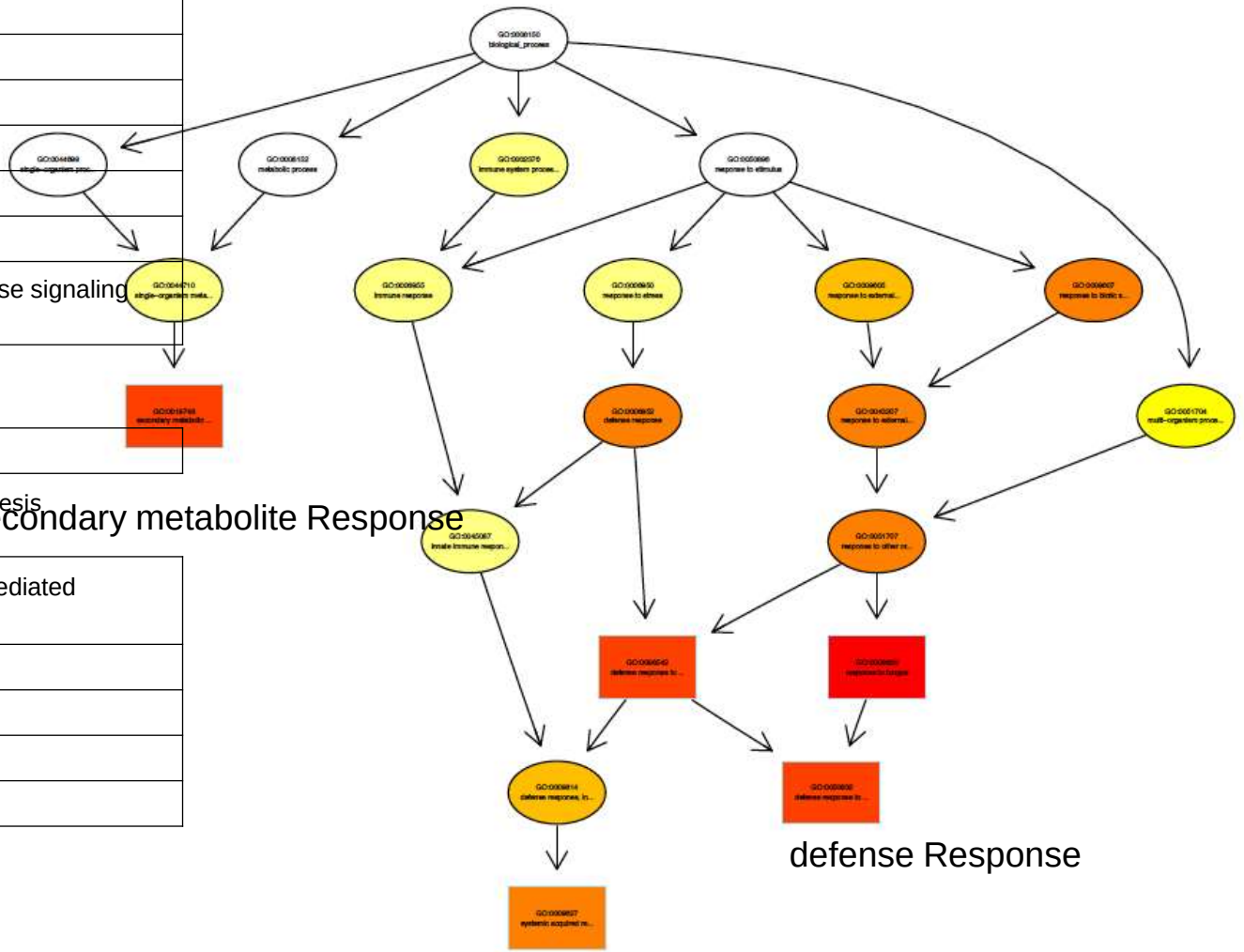
beta-glucan biosynthetic process

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



Secondary metabolite Response

defense Response

Systemic Acquired Response

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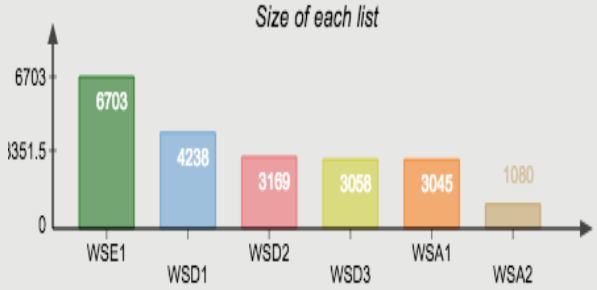
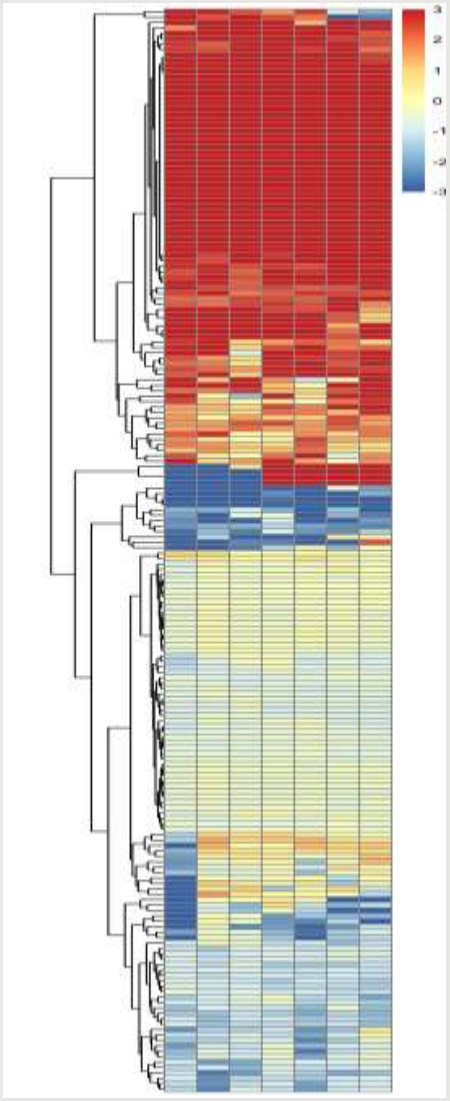
Runo et al 2018 (manuscript in preparation)

More *Striga* genes are differentially expressed in Striga infecting wild sorghum





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Runo et al 2018 (manuscript in preparation)

Cell wall, signaling, defense and transport genes are up regulated

GOBP_Term	Fold Enrichm	Bonferroni	Benjamini	FDR
GO:0044092~negative regulation of molecular function	4.36179291	3.55E-07	3.55E-07	3.55E-07
GO:0006865~amino acid transport	4.44821538	5.31E-07	2.65E-07	5.30E-07
GO:0046942~carboxylic acid transport	4.11777652	6.44E-07	2.15E-07	6.43E-07
GO:0015849~organic acid transport	4.11777652	6.44E-07	2.15E-07	6.43E-07
GO:0015837~amine transport	4.3818241	7.61E-07	1.90E-07	7.60E-07
GO:0043086~negative regulation of catalytic activity	4.27028676	3.28E-06	6.55E-07	3.27E-06
GO:0044042~glucan metabolic process	2.95526468	4.42E-06	7.36E-07	4.41E-06
GO:0007018~microtubule-based movement	3.86292388	1.39E-05	1.99E-06	1.39E-05
GO:0007047~cell wall organization	2.28930536	2.51E-05	3.14E-06	2.51E-05
GO:0045229~external encapsulating structure organization	2.24445106	2.68E-05	2.98E-06	2.68E-05
GO:0007167~enzyme linked receptor protein signaling pathway	2.98098864	4.63E-05	4.63E-06	4.62E-05
GO:0007169~transmembrane receptor protein tyrosine kinase signaling pathway	2.98098864	4.63E-05	4.63E-06	4.62E-05
GO:0007017~microtubule-based process	3.00861113	1.05E-04	9.56E-06	1.05E-04
GO:0006073~cellular glucan metabolic process	2.93582215	1.89E-04	1.58E-05	1.89E-04
GO:0007049~cell cycle	2.30850972	2.63E-04	2.03E-05	2.63E-04
GO:0005976~polysaccharide metabolic process	2.35938218	2.70E-04	1.93E-05	2.70E-04
GO:0009250~glucan biosynthetic process	3.44469799	0.00115008	7.67E-05	0.00114887
GO:0030243~cellulose metabolic process	3.61331957	0.00188836	1.18E-04	0.00188706
GO:0044264~cellular polysaccharide metabolic process	2.51641898	0.00284351	1.67E-04	0.0028429
GO:0015833~peptide transport	3.35522531	0.00643621	3.59E-04	0.00644633
GO:0006857~oligopeptide transport	3.35522531	0.00643621	3.59E-04	0.00644633
GO:0007166~cell surface receptor linked signal transduction	2.3629788	0.01155552	6.12E-04	0.01160327
GO:0006260~DNA replication	2.57779506	0.01878315	9.48E-04	0.01892924
GO:0033692~cellular polysaccharide biosynthetic process	2.73630025	0.0231982	0.00111707	0.02343069
GO:0051301~cell division	2.27957955	0.02485032	0.00114318	0.02512032
GO:0022402~cell cycle process	2.47227128	0.0278457	0.0012271	0.02819095
GO:0000271~polysaccharide biosynthetic process	2.63400866	0.04412546	0.00187859	0.04504525

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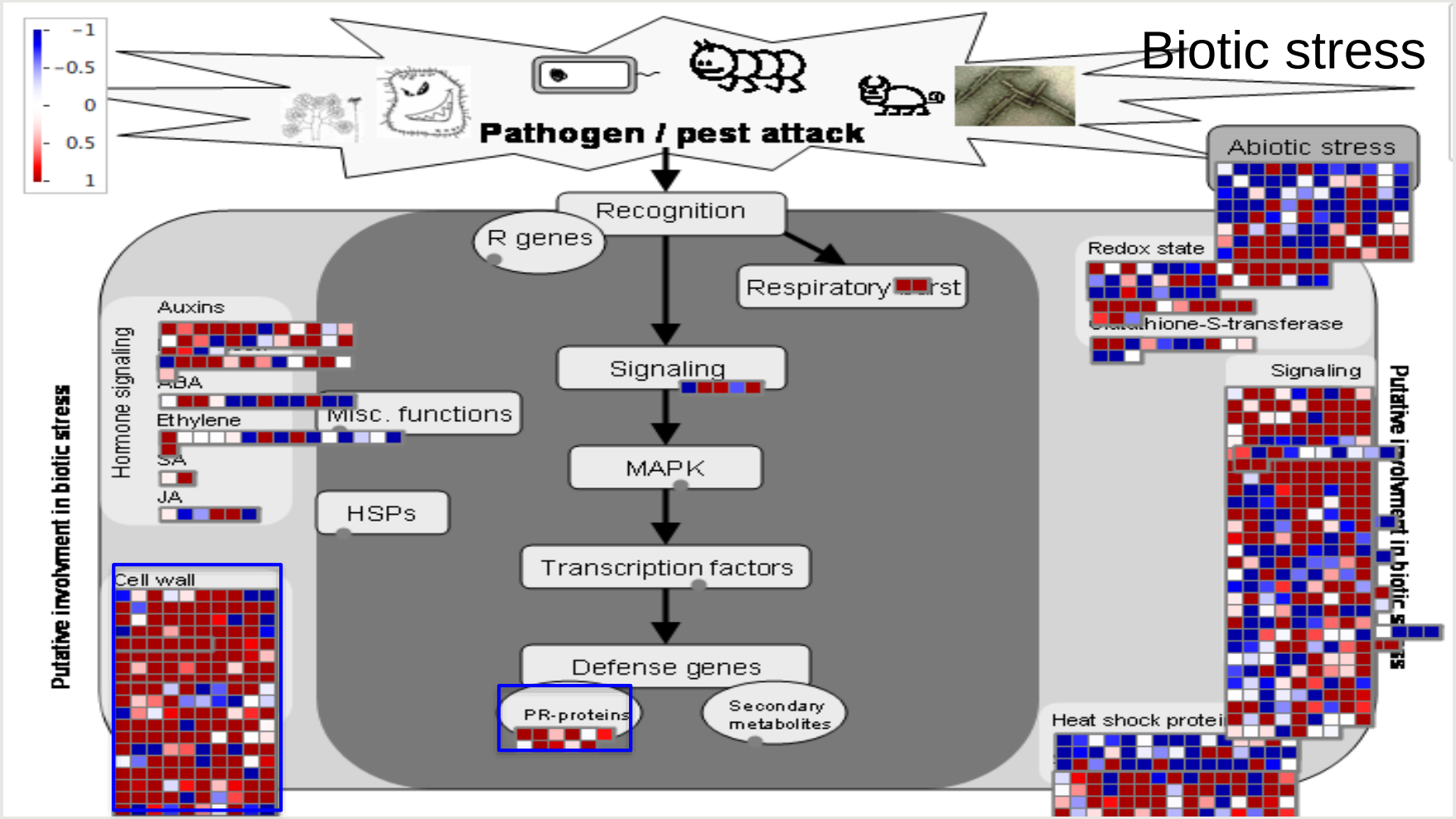

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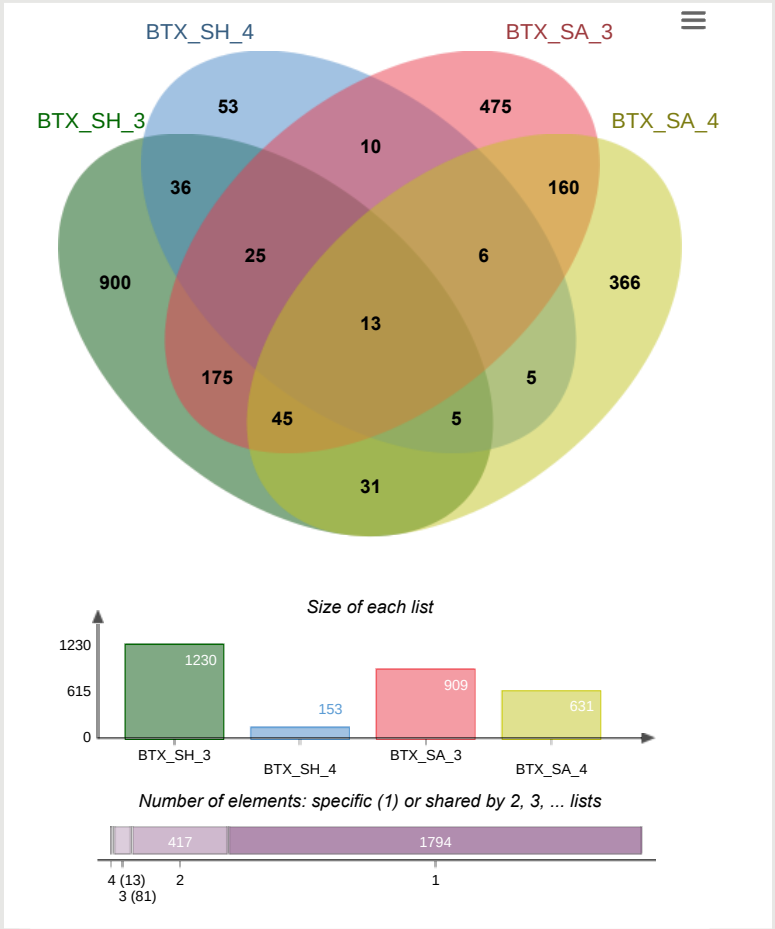
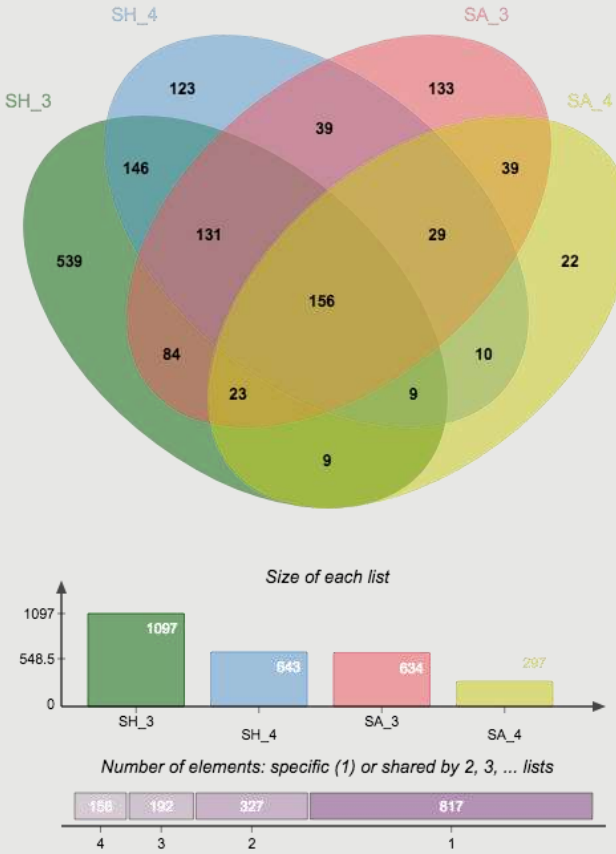
Derailing the witchweed: Mining for *Striga* effectors





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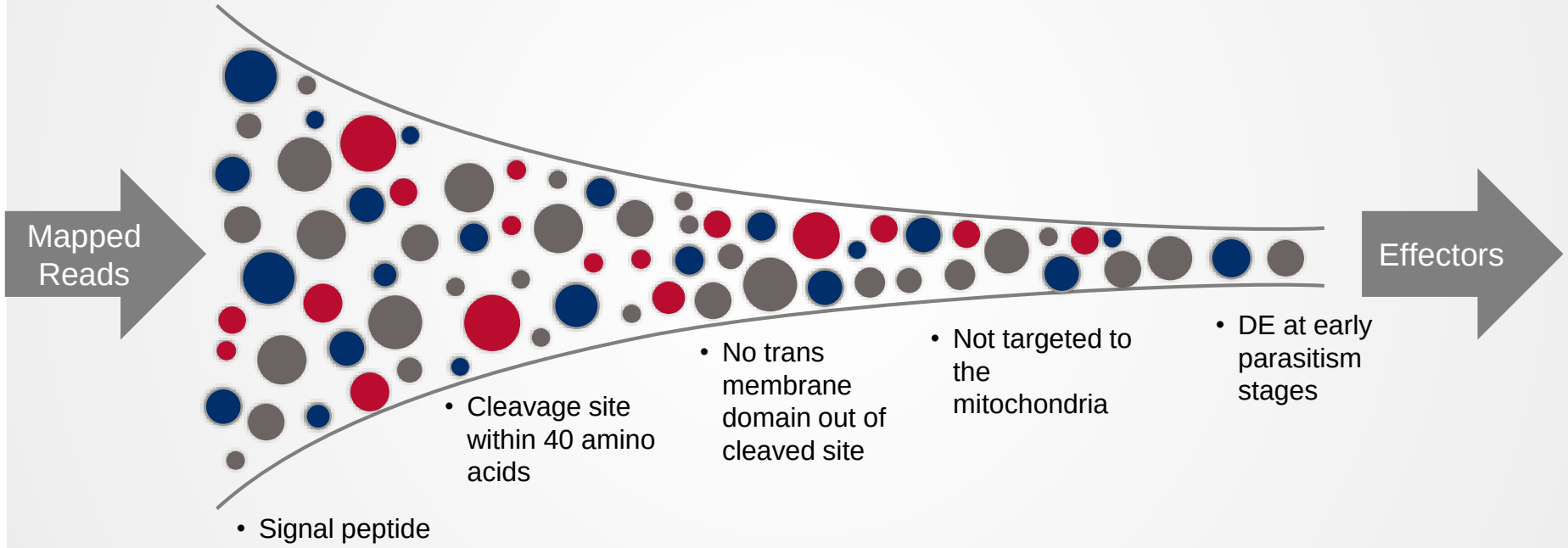
Runo et al., (Manuscript in preparation)

Pipeline for *Striga* effectors identification



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Runo et al., (Manuscript in preparation)

nature COMMUNICATIONS

ARTICLE

Received 29 Jan 2016 | Accepted 9 Sep 2016 | Published 27 Oct 2016

DOI: 10.1038/ncomms13188 OPEN

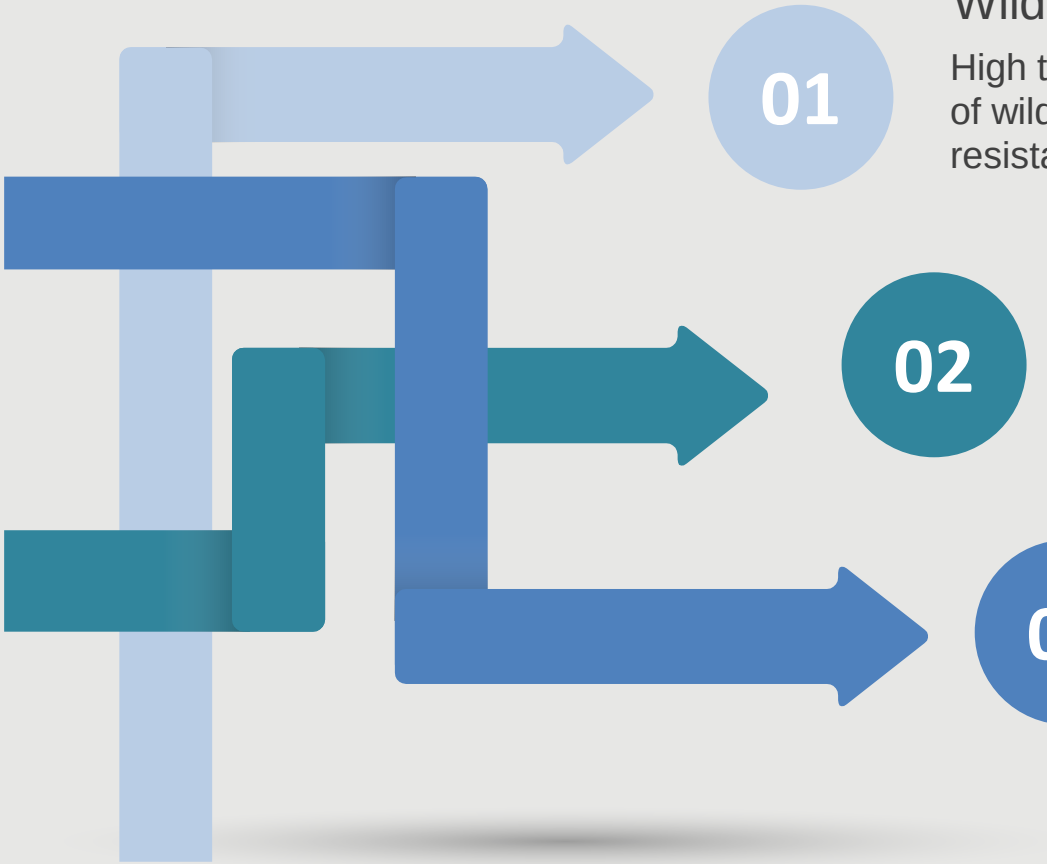
The fungal-specific β-glucan-binding lectin FGB1 alters cell-wall composition and suppresses glucan-triggered immunity in plants

Stephan Wawra[1,*], Philipp Fesel[1,*], Heidi Widmer[1], Malte Timm[2], Jürgen Seibel[2], Lisa Leson[1], Leona Kesseler[1], Robin Nostadt[3], Magdalena Hilbert[3], Gregor Langen[1] & Alga Zuccaro[1,3]

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

Approach

Genomic tools for identification of host resistance and pathogen virulence



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Genome wide association mapping of Striga resistance in a global diversity panel

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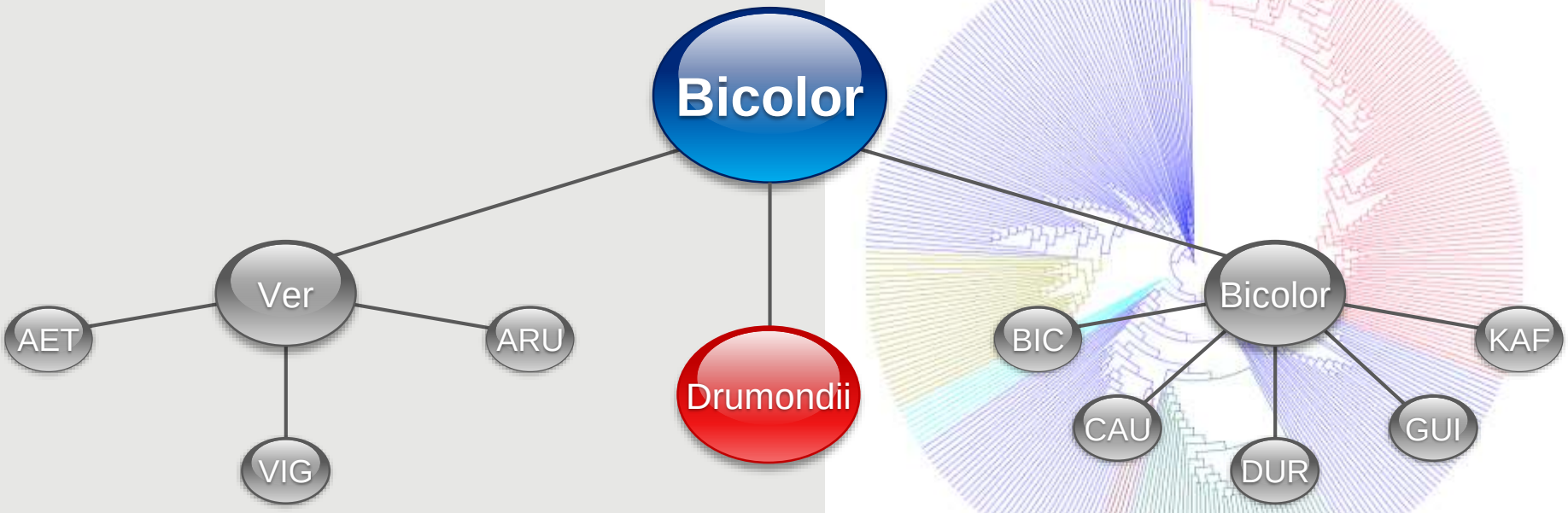
Kavuluko et al., (Manuscript in preparation)

Genome wide association mapping of *Striga* resistance in a global diversity panel



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Diverse resistance *Striga* resistance response in the diversity panel

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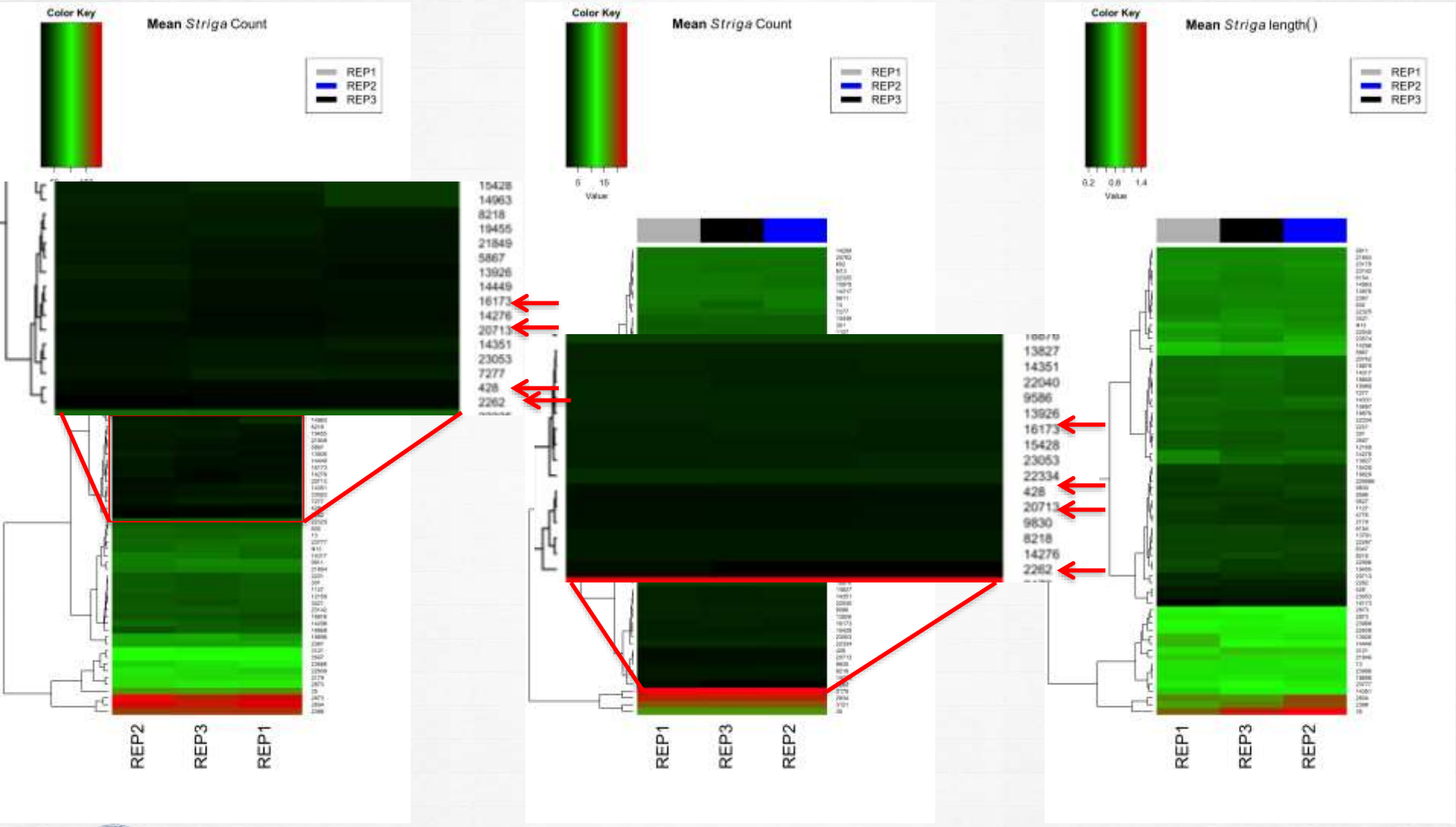
GWAS identifies of *Striga* resistance in a global diversity panel



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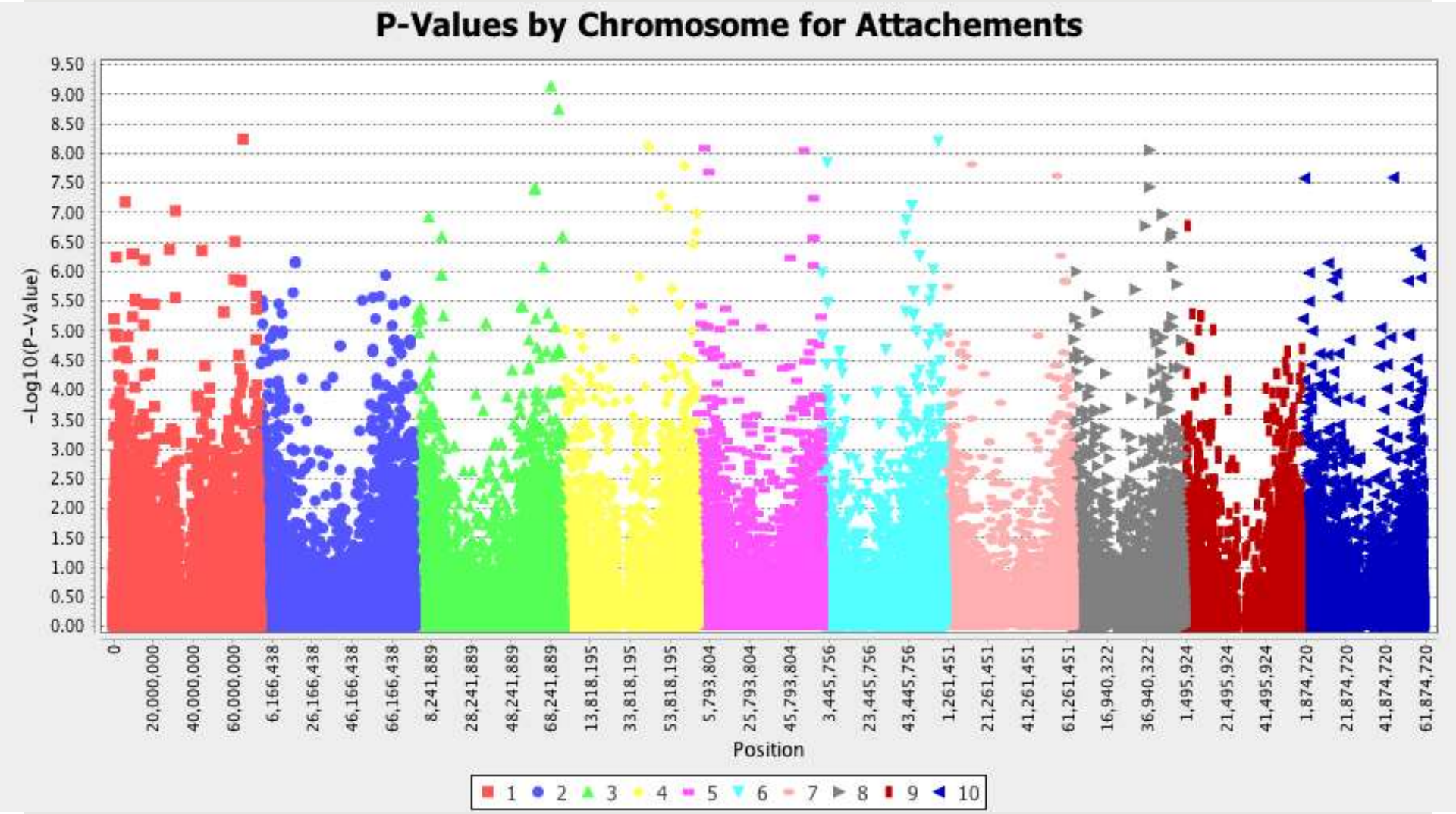
Kavuluko et al., (Manuscript in preparation)

GWAS “pinpoints” *Striga* resistance loci



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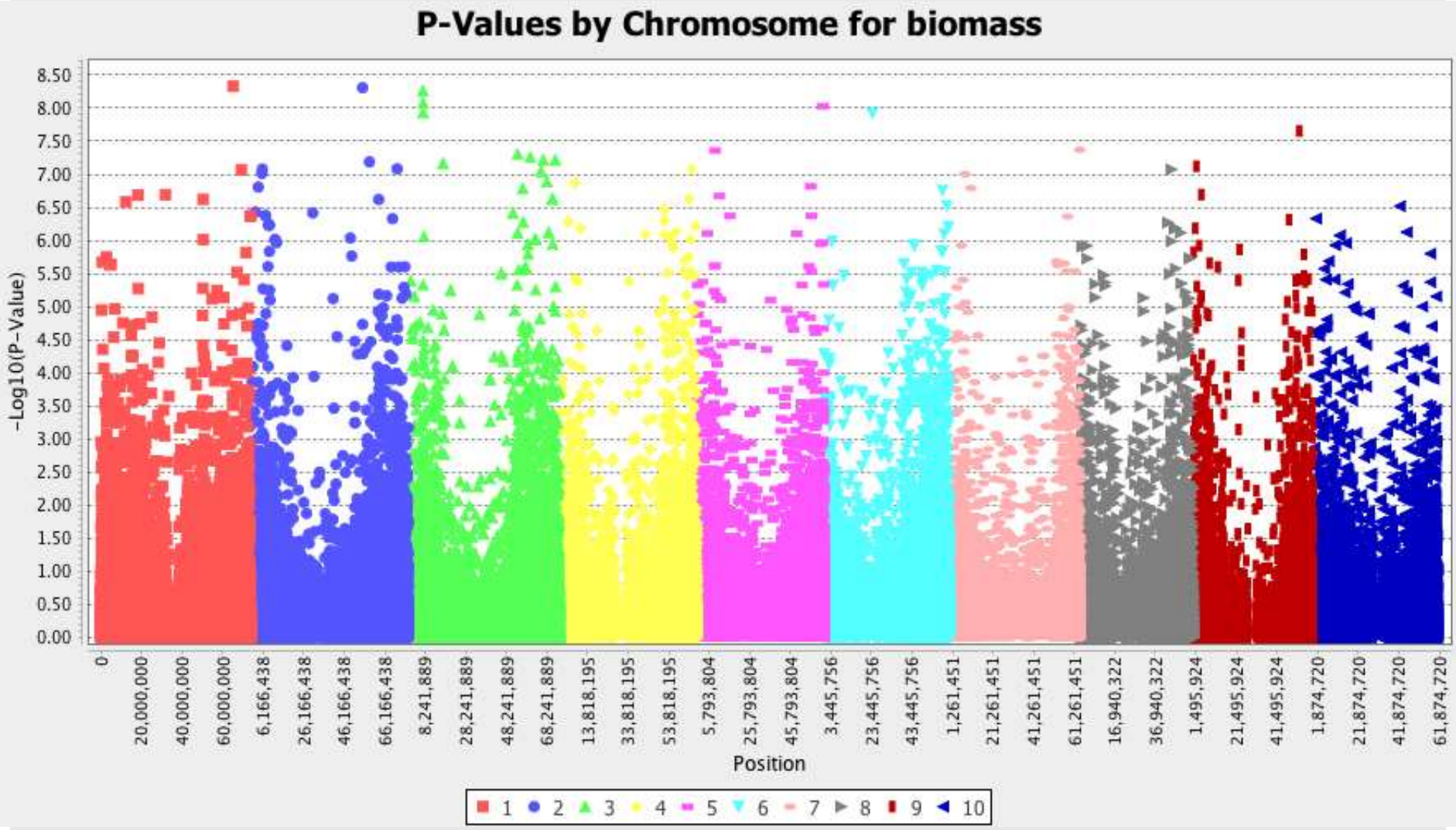

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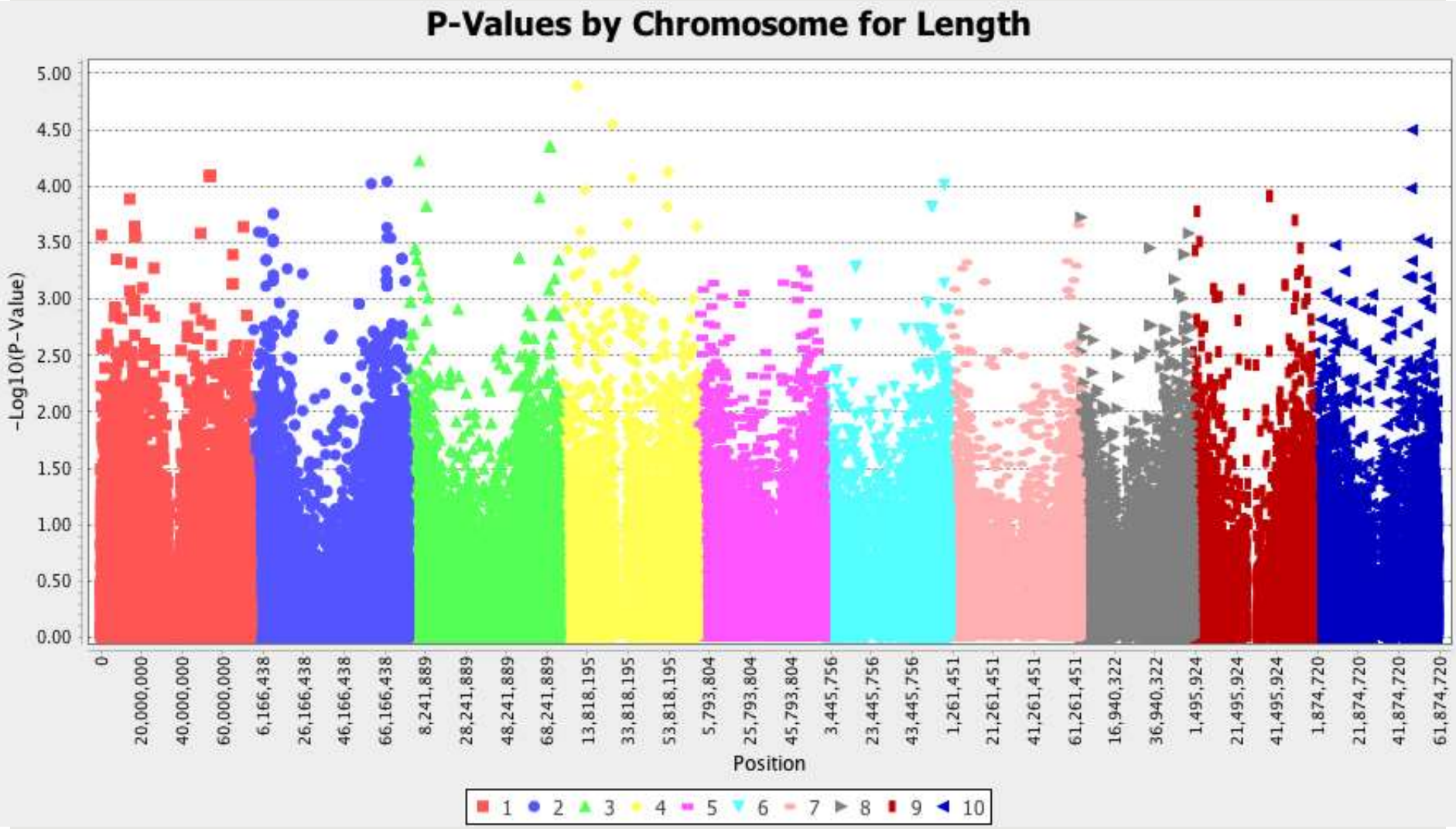

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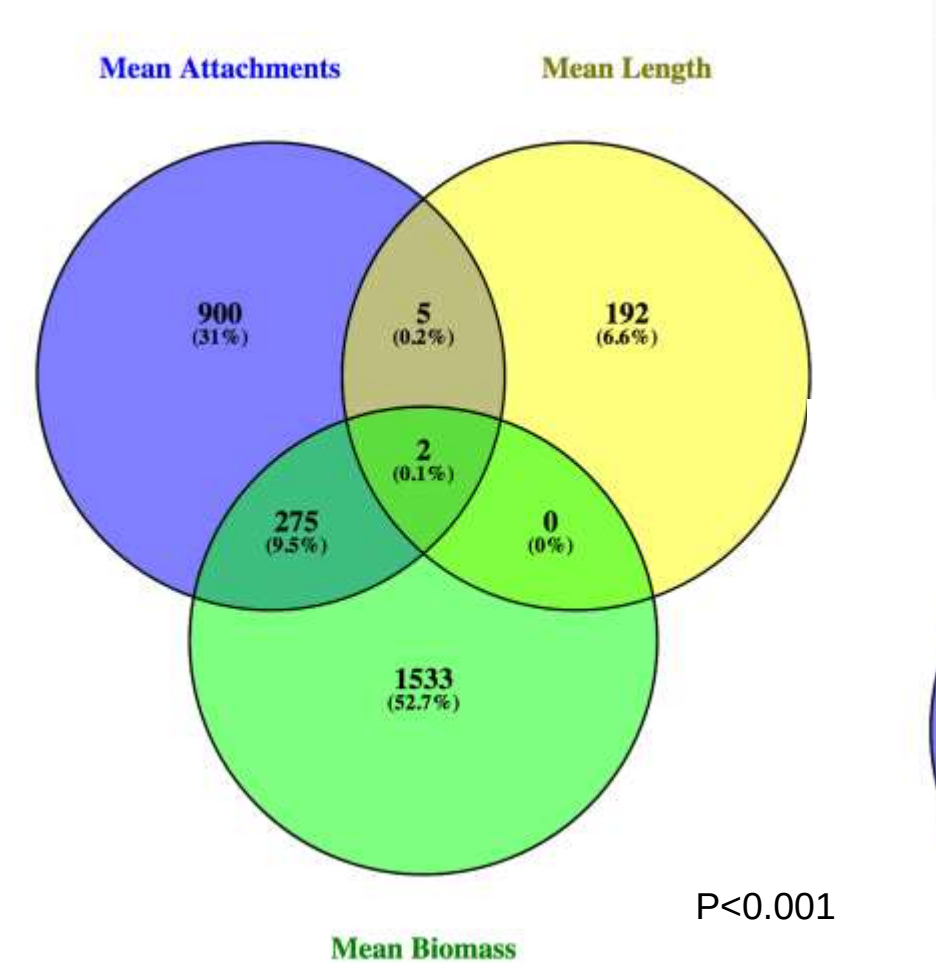
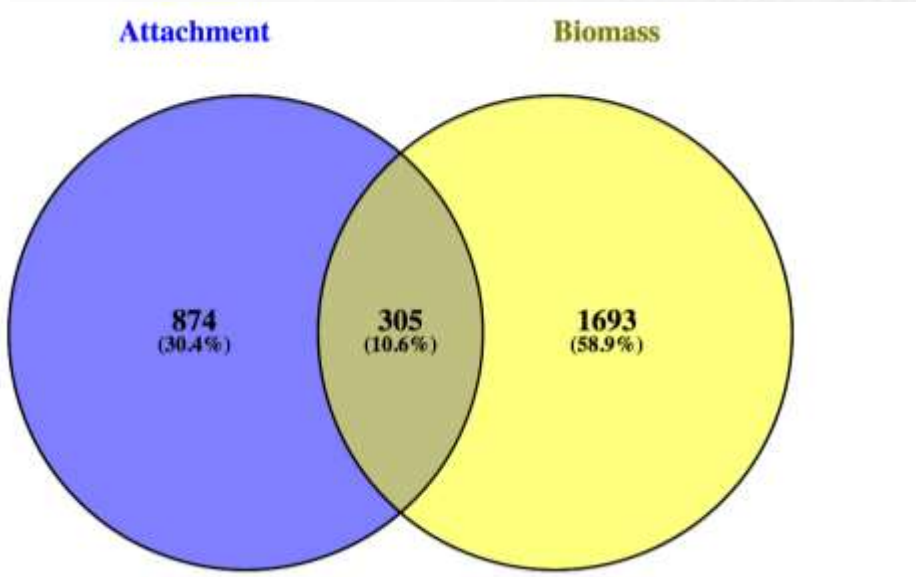


P<0.001

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

PNAS

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)

Research

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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- PPGP
- 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

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