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Novel Sources of Resistance to Biotic Stresses

Adapted: Huynh et al (2013)

Traits

- Root-Knot Nematode
- Fusarium Wilt
- Ashy Stem Blight
- Aphids

Landraces Genepool 2
Landraces Genepool 1
Wild Cowpeas

Adapted: Huynh et al (2013)
Research Objectives

1. Variability of Response
2. Genetic Uniqueness
3. Genetic Architecture
X. Input to Breeding
“Root-Knot Nematodes: A Global Menace to Crop Production.”


International *Meloidogyne* Project: Funded by USAID
Challenges with Root-knot Nematode

- Disease relevance;
- Pathogen host range;
- Disease complex;
- Population dynamics and shift in virulence;
- Management options;
- Genetic basis of resistance;
- Resistance spectrum;
- Availability of sources of genetic resistance.

<table>
<thead>
<tr>
<th>Nematode/ Fusarium wilt</th>
<th>CB3</th>
<th>CB5</th>
<th>CB46</th>
<th>CB27</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M. incognita</em> (Vir)</td>
<td>Res.</td>
<td>Susc.</td>
<td>Susc.</td>
<td>Susc.</td>
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Adapted: Hall et al (1996)
Pursuing RKN Resistance for Cowpea Breeding

- *Rk* gene;
- *Rk*²;
- *rk*³;
- Galling resistance gene;

- Novel *R* genes and biological spectrum among Mozambique germplasm?
Phenotyping Protocols for RKN Resistance

Seedling growth pouch inoculation

Greenhouse inoculation

Infested field screening
Novel Sources of Broad-Based RKN Resistance

Root Galling Response - *M. javanica* (Greenhouse-2013-14)
Workflow – Objectives 2 & 3

Susceptible x Resistant

- M. javanica
- M. incognita

F1

Leaf sampling at F2

DNA Extraction

Genotyping

F2

Controls

- Root galling
- Reproduction

F3

Phenotypic Response

QTL mapping

Analysis of goodness-of-fit
Phenotypic Response of F1 in FN-2-9-04 Crosses

**Root Galling, F1 Populations - *M. javanica***

- Gall Index

**Response of F1 progenies to Reproduction - *M. javanica***

- Egg Masses

**Cowpea Genotypes**

- CB46
- INIA-41
- UCR779
- CB46-Null
- Ecute
- FN-2-9-04 F1
Relationship of Novel Resistance to $Rk$ Gene

$Rk$ gene × Novel $R$-gene?

$M. Incognita$ (Avir) $\rightarrow$ No Segregation

Root Galling – Avirulent $M. incognita$

Exp. 1

Exp. 2

Root Galling, F1 Populations - $M. javanica$

Cowpea Genotypes
QTL Mapping Populations

Phenotyping
Nematodes
Root galling
> 150 F2 & 150 F2:3
Reproduction

Genotyping
51 128 SNP
17 208 Poly.
119 F2

QTL mapping: Mixed-model (Xu, 2013)

Root galling
Reproduction

M. javanica
M. javanica & M. incognita
Distribution of Root Gailing Response in F2 and F2:3

Root Gailing – *M. javanica*

- CB46-Null x FN-2-9-04
- CB46 x FN-2-9-04
- INIA-41 x FN-2-9-04

Root Gailing – Avirulent *M. incognita*
Heritability of Resistance in FN-2-9-04

X

F2

Offspring - Midparent Regression

y = 0.7551x
R² = 0.52

7 F2 Populations

Offspring (F2) Gallling Index (0-9)
Mid-Parent Gall Index (0-9)

0 1 2 3 4 5

0 1 2 3 4 5
Genomic Location of a Novel RKN Resistance QTL

F2 Population: Greenhouse Assay - *M. javanica*

PVE = 47%

F2 Population: Growth Pouch Assay - *M. javanica*

PVE = 34%
Genomic Location of the Novel RKN Resistance QTL

F3 Population: Field Assay - *M. javanica*

PVE = 94%

F3 Population: Field Assay - *Avr M. incognita*

PVE = 73%

PVE = 27%
Conclusions

- Allelism tests showed that, in addition to the Rk locus found in current cultivars, FN-2-9-04 carries unique RKN resistance factors;

- Resistance in FN-2-9-04 controlled by 2 major QTLs on Chr1 and Chr4;

- RKN root-galling and reproduction are under control of major genes with partial dominance, putatively with enhancement by minors factors;

- High heritability of resistance to *M. javanica* in FN-2-9-04 indicates easy selection for breeding RKN resistant cowpea cultivars.
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