2012 Breeding progress for rust resistance in confection sunflower

Li Gong[1,2], Sam Markell[2], Brent Hulke[1], Tom Gulya[1] and Lili Qi[1]
[1]USDA, ARS, NCSL, Fargo, ND
[2]NDSU – Plant Pathology, Fargo, ND

Objectives

1. Introgression of rust resistance genes into confection sunflower
2. Molecular mapping of rust resistance genes
3. Pyramiding *R*-genes in confection sunflower

1. Introgression of rust resistance genes

Recurrent parents (RP)

CONFSCL B1

CONFSCL R5

Highly susceptible to rust

R-gene donors

MC29 R_2

HA-R2 R_5

HA-R3 R_4

Recurrent
parent (RP) × R-gene donor

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RP × F_1

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In each generation, rust resistant plants were selected for backcross

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BC_4F_1 — 97% RP genome — Summer 2011

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BC_4F_2 — MAS of homozygous resistant plants — March 2012

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BC_4F_3 — Planting F_3 seeds in the field — Summer 2012

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BC_4F_4 — Field performance and seed harvest — Fall 2012

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Release rust resistant confection lines — Spring 2013

Marker assisted selection of homozygous rust resistance families

Rust genes	Homozygous families identified by MAS	Molecular markers
R_5 in HA-R2	16 out of 104 BC_4F_2 plants	ORS1197 and ORS653, Qi et al. 2012
R_4 in HA-R3	24 out of 168 BC_4F_2 plants	ZVG61 and ORS581, Qi et al. 2011
R_2 in CM29	5 heterozygous resistant 1 totally susceptible	ORS333 and ORS795, Lawson et al. 2011 published molecular markers did not work

2. Molecular mapping of rust resistance genes

Lines	Origin of rust resistance
RHA 397	South Africa
RHA 464	Wild *H. annuus* collected in CA
HA-R6	A breeding line from France
HA-R8	A landrace in Arizona, USA

2.1 Spectrum of rust resistance in HA-R6, HA-R8, RHA 397, RHA 464 and other sunflower lines

2.2 Allelic analysis of rust resistance genes in HA-R6, HA-R8, RHA 397, and RHA 464

2.3 Molecular mapping of rust resistance genes in this project

2.1 Spectrum of rust resistance in HA-R6, HA-R8, RHA397, RHA 464 and other sunflower lines

Lines	Rust races										
	300	304	334	336	337	376	377	734	736	776	777
HA 89	S	S	S	S	S	S	S	S	S	S	S
MC 90	S	S	S	S	S	S	S	S	S	S	S
RHA 340	R	S	S	S	S	S	S	S	S	S	S
MC 29 (Aus)	R	R	R	R	R	R	R	R	R	R	S
MC 29 (USDA)	R	R	R	R	R	R	R	R	R	R	S
HA-R2	R	R	R	R	R	R	R	R	S	R	S
HA-R3	R	MR	R	R	S	R	R	R	R	R	S
HA-R6	R	R	R	R	R	R	R	R	R	R	R
HA-R8	R	Seg.	Seg.	R	R	R	Seg.	R	Seg.	R	R
RHA 397	R	R	R	R	R	R	R	R	R	R	R
RHA 464	R	R	R	R	R	R	R	R	R	R	R
Rf ANN-1742	R	R	MR	R	R	R	R	R	MR	R	R
PH3	R	R	R	R	R	R	R	R	R	R	R
TX16R	R	R	R	R	R	R	R	R	R	R	R

R — rust resistance; MR — moderate resistance; S — rust susceptibility; Seg. — segregating for resistance

2.2 Allelic analysis of rust resistance genes in HA-R6, HA-R8, RHA 397, and RHA 464

HA-R6 × RHA397 → F_1 → F_2

220 R:0 S

HA-R6 × HA-R8 → F_1 → F_2

196 R:12 S

HA-R6 × RHA 464 → F_1 → F_2

229 R:21 S

HA-R8 × RHA 397 → F_1 → F_2

234 R:20 S

HA-R8 × RHA 464 → F_1 → F_2

194 R:13 S

RHA 397 × RHA 464 → F_1 → F_2

227 R:19 S

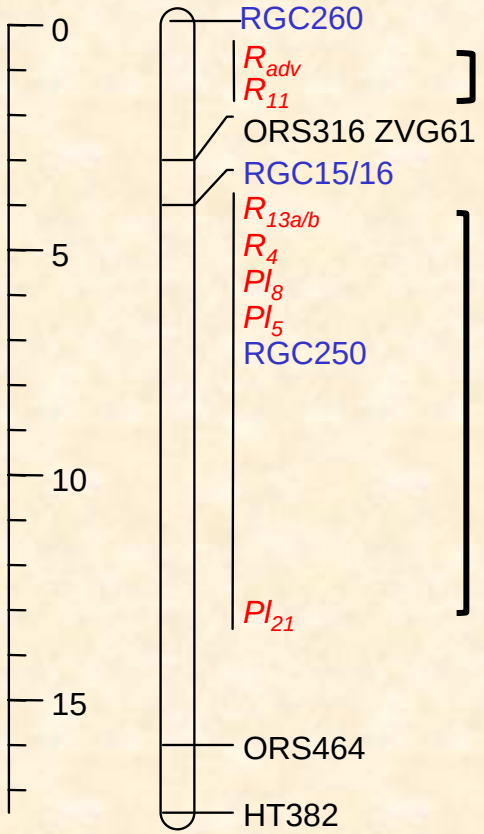
Only the segregation ratio (R:S) in the cross of HA-R6 and RHA 397 did not fit for the expected 15R:1S

Rust genes in HAR8 and RHA464 are independent, while those in HAR6 and RHA397 are alleles or closely linked

2.3 Molecular mapping of rust resistance genes in this project

Lines	Resistance genes	Linkage groups
MC 29 (USDA)	R_2	LG9
HA-R2	R_5	LG2
RHA 464	R_{12}	LG11
HA-R3	R_4	LG13
Rf ANN-1742	R_{11}	LG13
HA-R6	R_{13a}	LG13
RHA 397	R_{13b}	LG13
HA-R8	Unknown	Unknown

R-gene cluster on LG13



R-gene sub-cluster I

R-genes are closely linked to RGC (Resistance gene candidates) clusters

R-gene sub-cluster II

Rust genes: R_4, R_{11}, R_{13a} and R_{13b}, *and* R_{ADV}

Downy mildew genes: Pl_5, Pl_8, and Pl_{21}

3. Pyramiding *R*-genes in confection sunflower

Pyramiding of rust genes (R_2 and R_5) in new developed confection sunflowers with rust gene R_{13a} in HA-R6

homo-R_2 × HAR6 $\rightarrow$ F_1 $\rightarrow$ F_2 $\xrightarrow[\text{individuals carrying } R_2+R_{13a}]{\text{MAS}}$ F_3 ($R_2 + R_{13a}$) $\rightarrow$ $F_{4,}$ 2013

homo-R_5 × HAR6 $\rightarrow$ F_1 $\rightarrow$ F_2 $\xrightarrow[\text{individuals carrying } R_5+R_{13a}]{\text{MAS}}$ F_3 ($R_5 + R_{13a}$) $\rightarrow$ $F_{4\,,}$ 2013

Future work

1. Preparing seeds and documents to release rust resistant confection lines in 2013

2. After MAS, obtain F3 and F4 in rust gene pyramiding; releasing confection lines carrying two genes (R_2+ R_{13a}; R_5+ R_{13a}) in 2014

3. Continue identifying molecular markers linked to new rust resistance gene in HA-R8

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Thank you!