Progress on Introduction of Rust Resistance Genes into Confection Sunflower

Li Gong[1,2] Sam Markell[2], Brady Vick[1], Brent Hulke[1], Tom Gulya[1] and Lili Qi[1]

[1]USDA, ARS, NCSL, Fargo, ND
[2]NDSU – Plant Pathology, Fargo, ND

Background

- Increasing rust severity
  - 17% incidence in 2002
  - 60-77% incidence between 2005-2007
  - Incidence in North Dakota very high
- Confections are generally more susceptible to rust
- Limited resistance in commercial confection hybrids
- Genetic resistance very important
  - Yield loss with rust can be high
    - 1400 lb/A to 200 lb/A in Mohall, ND in 2008
    - Yield reduction of approx. 50% in Carrington hybrid performance trial, 2009 (Susceptible Confection Hybrids)
  - *275,700 A sprayed with fungicides in 2008

*Zollinger et al. 2009. NDSU Pesticide Use Survey 2008

Objectives

1. Transfer (introgression) rust resistance genes from oilseed sunflower to confection-type

2. Molecularly mark the resistance genes

Screening for rust resistance in USDA breeding lines

- *Race 336, the predominant race
- Race 777, the most virulent
- 104 lines were screened
  - 66 inbred lines
  - 14 interspecific lines
  - and 24 foreign lines

* Gulya and Markell. 2009. Sunflower rust status-2008 race frequency across the Midwest and resistance among commercial hybrids.

- Of 104 lines screened…
  - *13 were resistant to both races
  - *Six additional lines were resistant to race 336 only

*Qi et al, 2011, Identification of resistance to new virulent races of rust in sunflower and validation of DNA markers in the gene pools, Phytopathology

- Seven were selected as rust resistance donor in this project

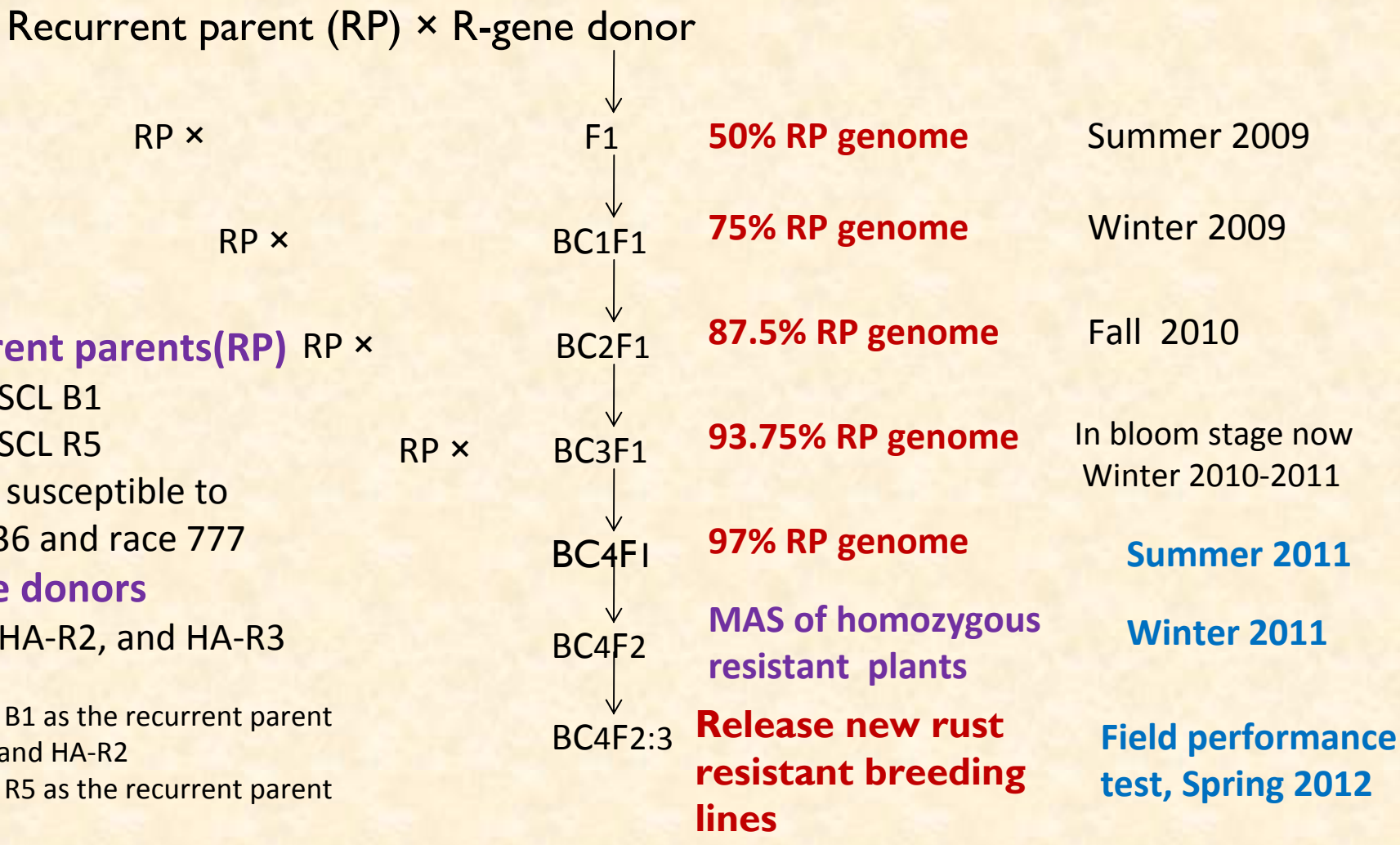
Rust resistance lines used in this project

Lines	Type	Rust resistance		Origin of rust resistance
		Race 336	Race 777	
MC29		R	S	Wild *H. annuus* in Texas
HA-R2	OB	R	S	Argentina open pollinated varieties
HA-R3	OB	R	MR	Argentina open pollinated varieties
HA-R6	CB	R	R	A breeding line from France
HA-R8	OR	R	R	A landrace in Arizona, USA
RHA397	OR	R	R	South Africa
RHA464	OR	R	R	Wild *H. annuus* collected in California

OB: oil-B line OR: oil-R line CB: confection B line

All rust resistance genes in cultivated sunflower can be traced to wild species, primarily from wild *H. annuus, H. argophyllus* and *H.petiolaris*

Scheme of transferring rust resistance genes into confection sunflower based on traditional backcross



Recurrent parents(RP)

- CONFSCL B1
- CONFSCL R5
- Highly susceptible to race 336 and race 777

R-gene donors

MC29, HA-R2, and HA-R3

CONFSCL B1 as the recurrent parent of MC29 and HA-R2
CONFSCL R5 as the recurrent parent of HA-R3

Molecular markers for the new rust resistance genes

- Marker-assisted selection is a powerful approach for pyramiding non-allelic rust resistance genes

- Only a few molecular markers are available for sunflower rust resistance and no molecular markers are available to the rust resistant breeding lines used in this project.

Molecular marker-assisted R-gene selection

Molecular markers linked to new R-genes

R-gene donors	resistance genes	Linked markers	Linkage (cM)	Linkage groups	References
MC29	*R2*	**ORS333**	0.0	9	Lawson et al, 2010
HA-R2	*R5*	**ORS1197** **ORS653**		2	Qi, unpublished
HA-R3	*R4*	**ZVG61** **ORS581**	2.1 0.8	13	Qi, unpublished
HA-R6	underway				
HA-R8					
RHA397					
RHA464					

Mapping of new rust resistance genes

- HA-R6, HA-R8, RHA397 and RHA464 resist both rust races 336 and 777.
  - RHA464 resists downy mildew new race 734 as well
- Four F2 populations were created for mapping these rust resistance genes

F2 Populations	Harvest of F2 seeds	No. of F2 plants	Harvest of F3 seeds	Rust test for F2 derived F3 families
HA89 × RHA464	Spring, 2010	130	Fall, 2010	underway
HA89 × HAR6	Fall, 2010	150	Spring, 2011	
HA89 × HAR8	Fall, 2010	150	Spring, 2011	
HA89 × RHA397	Fall, 2010	150	Spring, 2011	

Screening of polymorphism among parents using 870 mapped SSR markers

Cross combination	No. of Polymorphic SSRs	Percentage (%)
HA89 × HAR6	439	50.5
HA89 × HAR8	465	53.4
HA89 × RHA397	410	47.1
HA89 × RHA464	398	45.7

1. HA89 2. RHA397 3. HA-R6 4. HA-R8 5. RHA464

Future work and Anticipated Impacts

- Continue to backcross with recurrent parents. The confection breeding lines resistant to the predominant race will be released in the fall of 2012. Finally, farmers will directly benefit from rust resistant hybrids.

- Identify molecular markers linked to new rust resistance genes which will speed up the selection of rust resistant plants

- investigate the allelic relationships among new rust resistance genes in this project. This will reveal whether or not the rust resistance in these different materials are controlled by the same gene.

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