

# 2015 Progress for Development of Super Confection Sunflower Effectively Resistant to Downy Mildew and Rust

**Guojia Ma<sup>1,2</sup>, Samuel Markell<sup>1</sup>, Lili Qi<sup>2</sup>**

**<sup>1</sup>NDSU – Plant Pathology, Fargo, ND**

**<sup>2</sup>USDA, ARS, NCSL, Fargo, ND**

# Outline

- Background knowledge
- DM- and rust-R confection sunflower germplasm development
- Mapping of DM-R gene in RHA 468
- Mapping of DM-R gene in PI 494578
- Future work
- Acknowledgements

# Background Knowledge

## DM

- *Plasmopara halstedii*



## Rust

- *Puccinia helianthi*



(Photo by Markell and Gong)

- Serious sunflower diseases in the world
- Development of resistant hybrids is most economic tool for disease management

# Research Objectives in 2015

- Create the BC<sub>3</sub> generation in the spring greenhouse and BC<sub>4</sub> generation
- Test all generations in greenhouse/laboratory for resistance
- Complete the molecular mapping of DM resistance gene in RHA 468
- Begin the process of identifying molecular markers for a new DM resistance gene derived from *H. argophyllus* PI 494578

# Research Strategy

## *Initial crosses*

- ✓ CONFSLR5 × RHA 464 ( $R_{12}$  +  $PI_{ARG}$ )
- ✓ HA-R6 ( $R_{13a}$ ) × HA 458 ( $PI_{17}$ )
- ✓ HA-R6 ( $R_{13a}$ ) × HA-DM1 ( $PI_{18}$ )

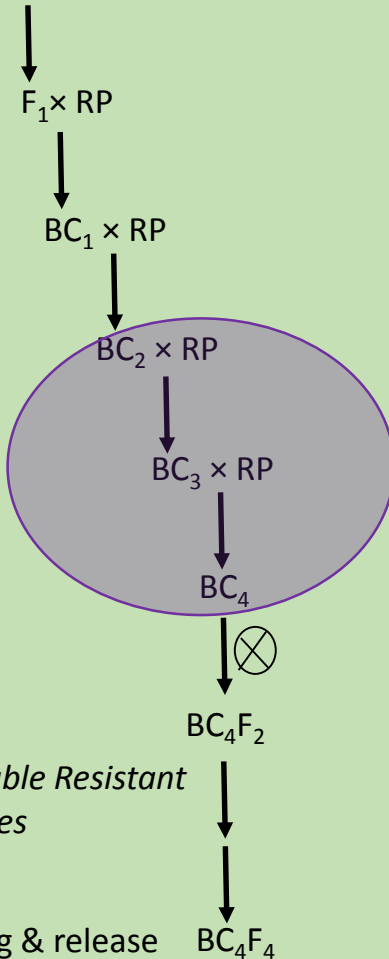


*Final products ( $BC_4F_4$ )*

- Confection line 1:  $R_{12}$  +  $PI_{ARG}$
- Confection line 2:  $R_{13a}$  +  $PI_{17}$
- Confection line 3:  $R_{13a}$  +  $PI_{18}$

## *Backcrosses*

Recurrent Parent × R-Parent



# Cross-BC<sub>1</sub>-BC<sub>2</sub>-**BC<sub>3</sub>**-BC<sub>4</sub>F<sub>1</sub>-BC<sub>4</sub>F<sub>2</sub>-BC<sub>4</sub>F<sub>3</sub>-BC<sub>4</sub>F<sub>4</sub>

- DM (race 734) and rust (race 336) testing of BC<sub>2</sub> of CONFSCLR5 × RHA 464
- DM (race 734) testing of BC<sub>2</sub> of HA-R6 × HA 458 and HA-R6 × HA-DM1

BC <sub>2</sub>	No. of seeds inoculated	No. of DM R-plants	No. of DM & rust double R-plants
CONFSCLR5 × RHA 464 ( <i>R</i> <sub>12</sub> + <i>PI</i> <sub>ARG</sub> )	156	52	22
HA-R6 ( <i>R</i> <sub>13a</sub> ) × HA 458 ( <i>PI</i> <sub>17</sub> )	60	24	24
HA-R6 ( <i>R</i> <sub>13a</sub> ) × HA-DM1 ( <i>PI</i> <sub>18</sub> )	68	33	33

- Selected resistant BC<sub>2</sub> individuals were tested with associated DNA markers
- Backcross of the selected BC<sub>2</sub> to respective recurrent parents to produce BC<sub>3</sub>

# Cross-BC<sub>1</sub>-BC<sub>2</sub>-BC<sub>3</sub>-**BC<sub>4</sub>F<sub>1</sub>**-BC<sub>4</sub>F<sub>2</sub>-BC<sub>4</sub>F<sub>3</sub>-BC<sub>4</sub>F<sub>4</sub>

- DM and rust testing of BC<sub>3</sub> of CONFSLR5 × RHA 464
- DM testing of BC<sub>3</sub> of HA-R6 × HA 458 and HA-R6 × HA-DM1

BC <sub>3</sub>	No. of seeds inoculated	No. of DM R-plants	No. of DM & rust double R-plants
CONFSLR5 × RHA 464 ( <i>R</i> <sub>12</sub> + <i>Pl</i> <sub>ARG</sub> )	135	56	20
HA-R6 ( <i>R</i> <sub>13a</sub> ) × HA 458 ( <i>Pl</i> <sub>17</sub> )	238	92	92
HA-R6 ( <i>R</i> <sub>13a</sub> ) × HA-DM1 ( <i>Pl</i> <sub>18</sub> )	112	36	36

- Selected resistant BC<sub>3</sub> individuals were tested with associated DNA markers
- Backcross of the selected BC<sub>3</sub> to respective recurrent parents to produce BC<sub>4</sub>

## Currently, working on

- DM and rust testing of  $BC_4F_1$  of CONFSCLR5 × RHA 464
- DM testing of  $BC_4F_1$  of HA-R6 × HA 458 and HA-R6 × HA-DM1
- Selected resistant  $BC_4F_1$  individuals were tested with DNA markers
- Selfing of the selected  $BC_4F_1$  to produce  $BC_4F_2$



# Research Objectives in 2015

- Create the BC<sub>3</sub> generation in the spring greenhouse and BC<sub>4</sub> generation
- Test all generations in greenhouse/laboratory for resistance
- Complete the molecular mapping of DM resistance gene in RHA 468
- Begin the process of identifying molecular markers for a new DM resistance gene derived from *H. argophyllus* PI 494578

# Mapping of DM-R Gene in RHA 468

- RHA 468: RHA 428/RHA 426//RO 12-13/3/RHA 274/PRS 5
  - Resistant to all DM races tested, with unknown genetics yet
- HA-R8
  - Susceptible to DM
- Mapping populations
  - Genotyping was performed on  $F_2$  pop
  - Phenotype was determined from  $F_{2:3}$  families
  - Chi-square test suggests DM resistance in RHA 468 is controlled by a single dominant gene

# Mapping of DM-R Gene in RHA 468, *cont.*

- The DM-R gene was located to linkage group (LG) 1 of the sunflower genome with bulked segregant analysis (BSA)
- **12** out of 50 SSR markers previously mapped to LG 1 showed polymorphism between parents
- DM-R gene was mapped to the top end of LG 1
- Further saturation with SNP markers: **37** out of 64 were polymorphic
- DM-R gene in RHA 468 was mapped to an interval of **1.3 cM**

# Research Objectives in 2015

- Create the BC<sub>3</sub> generation in the spring greenhouse and BC<sub>4</sub> generation
- Test all generations in greenhouse/laboratory for resistance
- Complete the molecular mapping of DM resistance gene in RHA 468
- Begin the process of identifying molecular markers for a new DM resistance gene derived from *H. argophyllus* PI 494578

# Mapping of DM-R Gene in PI 494578

- *H. argophyllus* PI 494578
  - DM-resistant lines with unknown genetics yet
  - Collected at Premont, TX
- HA 89: susceptible to DM
- Mapping populations
  - Genotyping on BC<sub>1</sub>F<sub>2</sub> pop
  - Phenotyping on BC<sub>1</sub>F<sub>3</sub> pop



# Phenotyping of DM Resistance in PI 494578

DM evaluation in BC<sub>1</sub>F<sub>3</sub> population

- 114 F<sub>2:3</sub> were inoculated with DM race 734
- Segregation deviation is observed
- DM resistance in PI 494578 is believed to be controlled by a single dominant gene, and further confirmation is needed

# Future Work (2016)

- Super confection DM- and rust-R sunflower project
  - Marker-assisted selection of double homozygous BC<sub>4</sub>F<sub>2</sub> individuals, and advance to BC<sub>4</sub>F<sub>3</sub> generations
  - Greenhouse test for BC<sub>4</sub>F<sub>3</sub> generations for resistance
  - Marker confirmation for BC<sub>4</sub>F<sub>3</sub> generations in lab
  - Seed increase and agronomic performance evaluation in field
  - Prepare to release confection germplasm showed both resistance to rust and DM
- Complete molecular mapping of the resistance gene in the line RHA 468 and manuscript writing
- Genotyping of DM-R gene derived from *H. argophyllus* PI 494578 and linkage analysis

# Acknowledgements

- Angelia Hogness (USDA, ARS, NCSL, SPBR)
- Dr. Zahirul Talukder (Dept. of Plant Sciences, NDSU)
- Mitchell Stephens (Dept. of Plant Sciences, NDSU)
- Cullen Walser (Dept. of Plant Sciences, NDSU)
  
- National Sunflower Association
- Specialty Crop Block Grant, USDA-AMS through ND Department of Agriculture



*Thank you  
&  
Questions?*