Development of Host-Plant Resistance as a Strategy to Reduce Damage from the Major Sunflower Insect Pests

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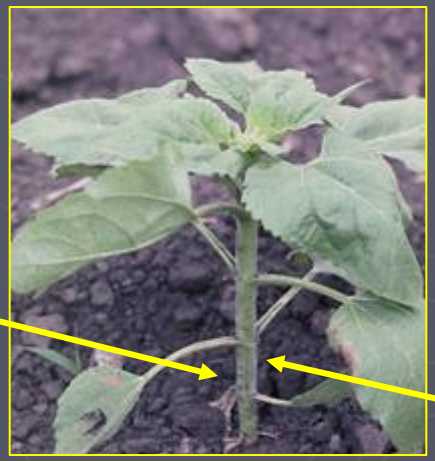
Objectives of Projects

- Host-plant resistance is an important tactic in an integrated pest management crop protection program
- Screen sunflower accessions, interspecific crosses, and lines for reduced damage or larval numbers: banded sunflower moth, red sunflower seed weevil, sunflower moth sunflower stem weevil & longhorned beetle
- Evaluate hybrids for tolerance to larval feeding by: sunflower midge
- Discovery of germplasm that has lower insect damage can provide breeding material to be incorporated into hybrids targeted to locations where specific insect problems occur
- Long-term goal = identify germplasm with resistance or tolerance to > one insect pest

Insects attacking the sunflower leaves & stem

Sunflower stem weevil



Sunflower stem girdler or longhorned beetle

Insects attacking the sunflower head & seeds

Sunflower moth

Red sunflower seed weevil

Banded sunflower moth

Sunflower midge

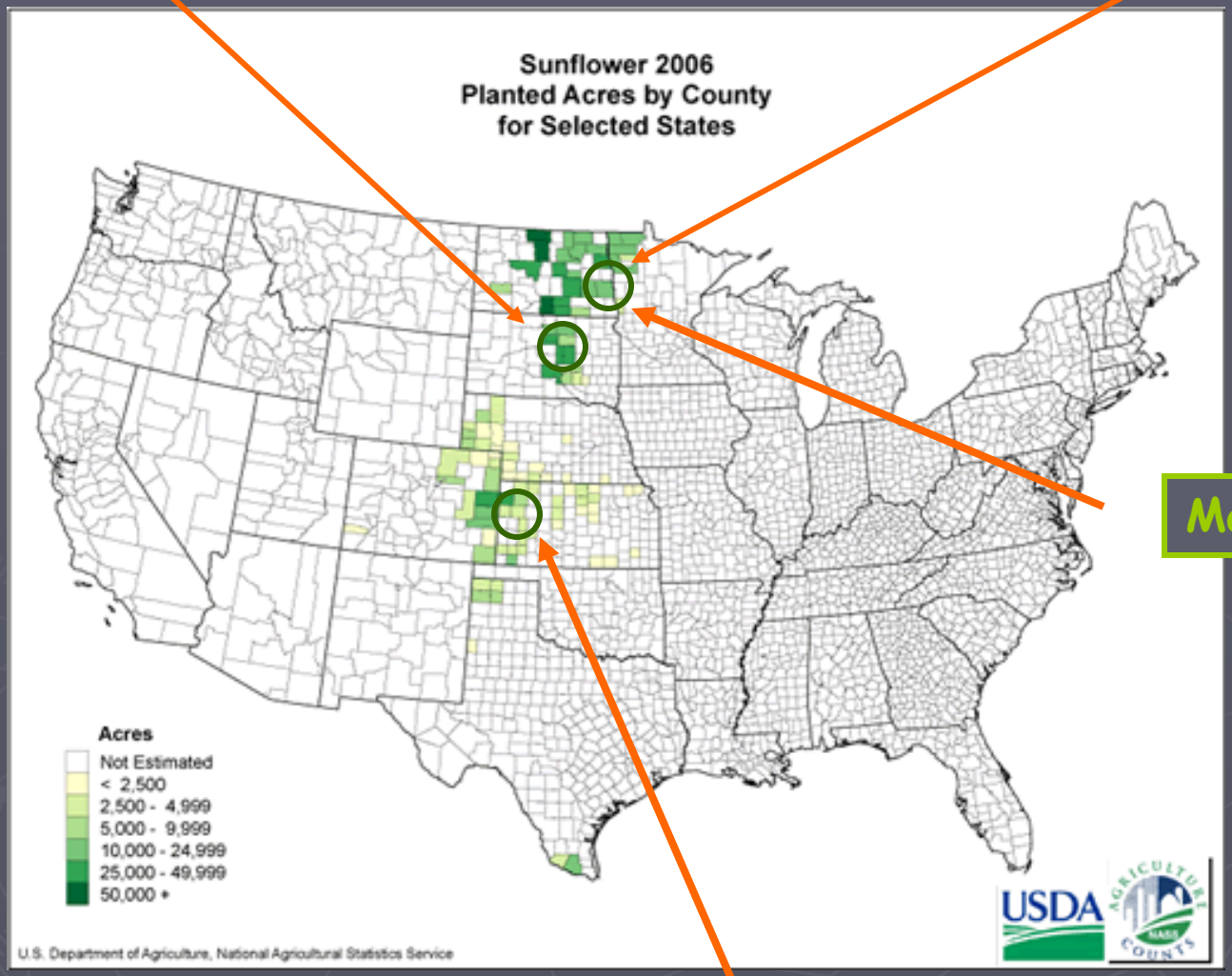
Insect Resistance Evaluation Trial Locations

Highmore, SD

Seed Weevil

Prosper, ND

Banded Moth & Seed Weevil



Mapleton, ND

Sunflower midge

Stem Weevil & Sunflower Moth

Colby, KS

Host Plant Resistance

- Uses plant's own defense
  (antibiosis, antixenosis, tolerance)
- Developed through plant screening & breeding
- Cost effective & environmentally safe
- Usually compatible with other approaches

Challenges Evaluating Sunflower for Insect Resistance

- Variable insect population pressure
  - ✓ Year to year densities often unpredictable
  - ✓ Coordination of insect presence/attack & plant phenology
- Environmental & biotic limitations
  - ✓ Drought or excessive moisture & wind
  - ✓ Birds
  - ✓ Plant disease
- Labor (time & costs) in determination of insect damage
- Post-harvest evaluation

Stem Weevil Biology

Eggs

deposited around cotyledon or lower stem

Larvae

feed & develop in sunflower stem

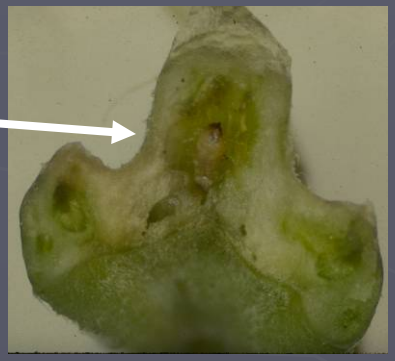
Adult

Overwintering chambers

weakens the structure of the stalk which can result in lodging

Sunflower Longhorned Beetle

Larva in leaf petiole



Stalk broken at soil level

Overwinter at base of stalk protected by plug of shredded plant fiber

Sunflower Moth

- Adults attracted to blooming heads
- Eggs deposited on heads & hatch in 4-5 days
- Larvae feed on pollen, disk flowers & mature seeds
- Each larva damages ~ 96 florets & consumes 3-12 seeds during development
- Mature larvae move to soil & spin cocoons to overwinter

Webbing & frass may occur in areas on head & Rhizopus head rot is often associated with infestations

Banded Sunflower Moth

Eggs laid on bracts of sunflower head

Larva feeding on florets

Damaged seeds

Entire contents of seed consumed

Exit holes

Webbing from larval feeding

Red Sunflower Seed Weevil

Drop into soil to overwinter

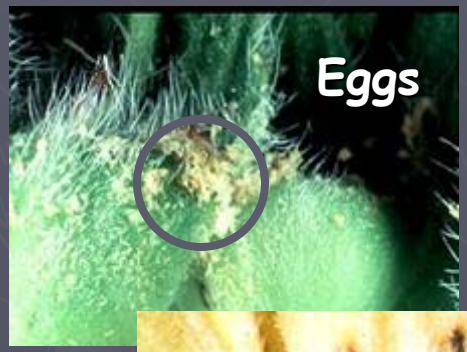
- ✓ Females require pollen to mature eggs
- ✓ Oviposit during flowering
- ✓ Heads with 50% flowering preferred
- ✓ Eggs laid inside seed
- ✓ Larvae in outer seed rows
- ✓ Kernel 1/3 consumed

Exit holes

Sunflower Midge

Adults

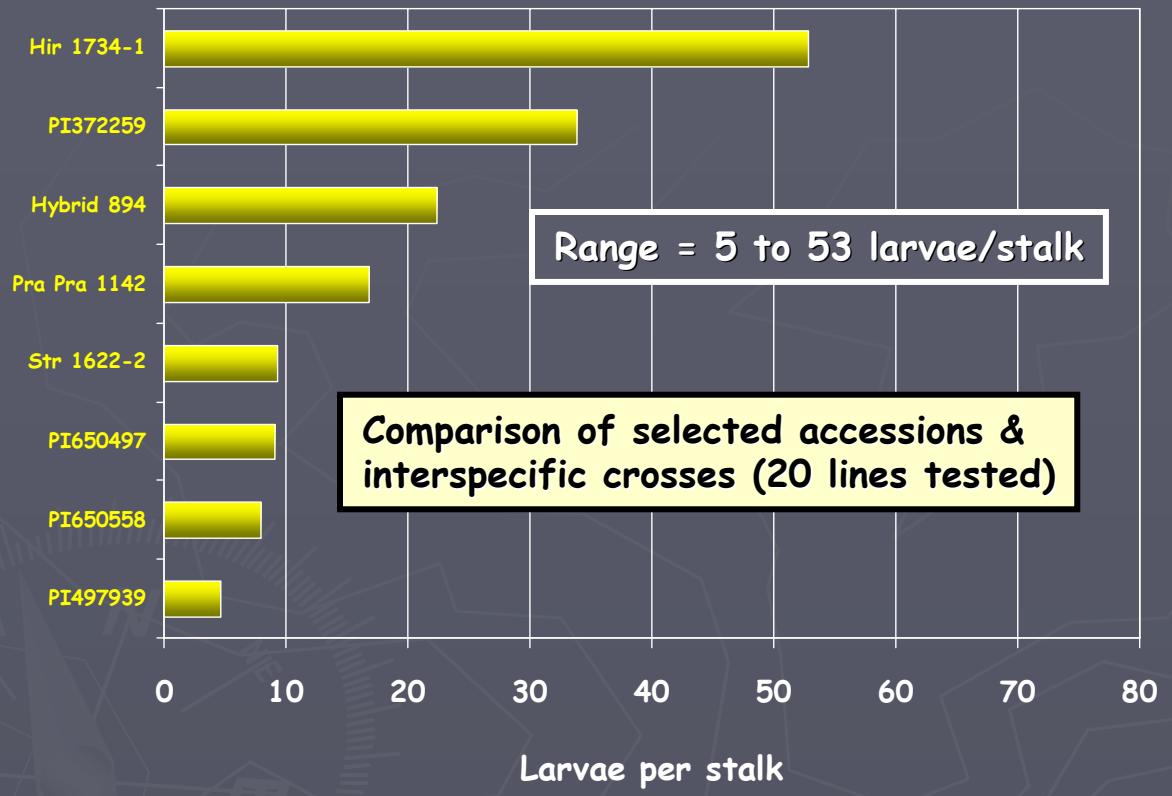
Necrotic tissue under bracts caused by larval feeding; loss of ray flowers



Larvae

Heavily damaged heads: gnarled & cupped with few seeds produced

Stem Weevil Resistance Trial 2007



Range = 5 to 53 larvae/stalk

Comparison of selected accessions & interspecific crosses (20 lines tested)

S1s trial
37 lines including checks
Range 6 to 64 larvae/stalk
21 with < 16 larvae/stalk

Jerry's Crosses trial
83 lines including checks
Range 2 to 40 larvae/stalk
48 with < 16 larvae/stalk
13 with < 10 larvae/stalk

Longhorned beetle infestation also was reduced in some lines in all trials

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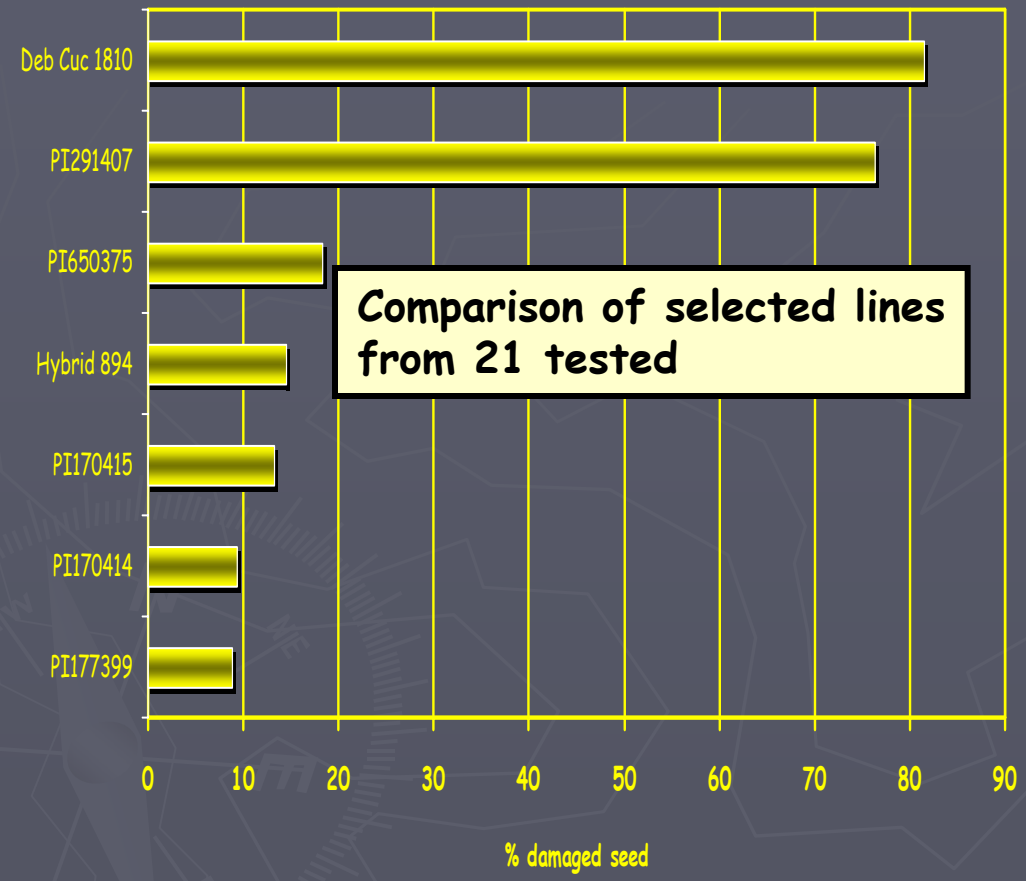
Sunflower Moth Trial 2007



S1s trial
29 lines including checks tested
Range 2 to 100% damaged seed
4 with < 25 % damage

Jerry's Crosses trial
65 lines including checks tested
Range 3 to 91% damaged seed
14 with < 20% damage
6 with < 10 damage

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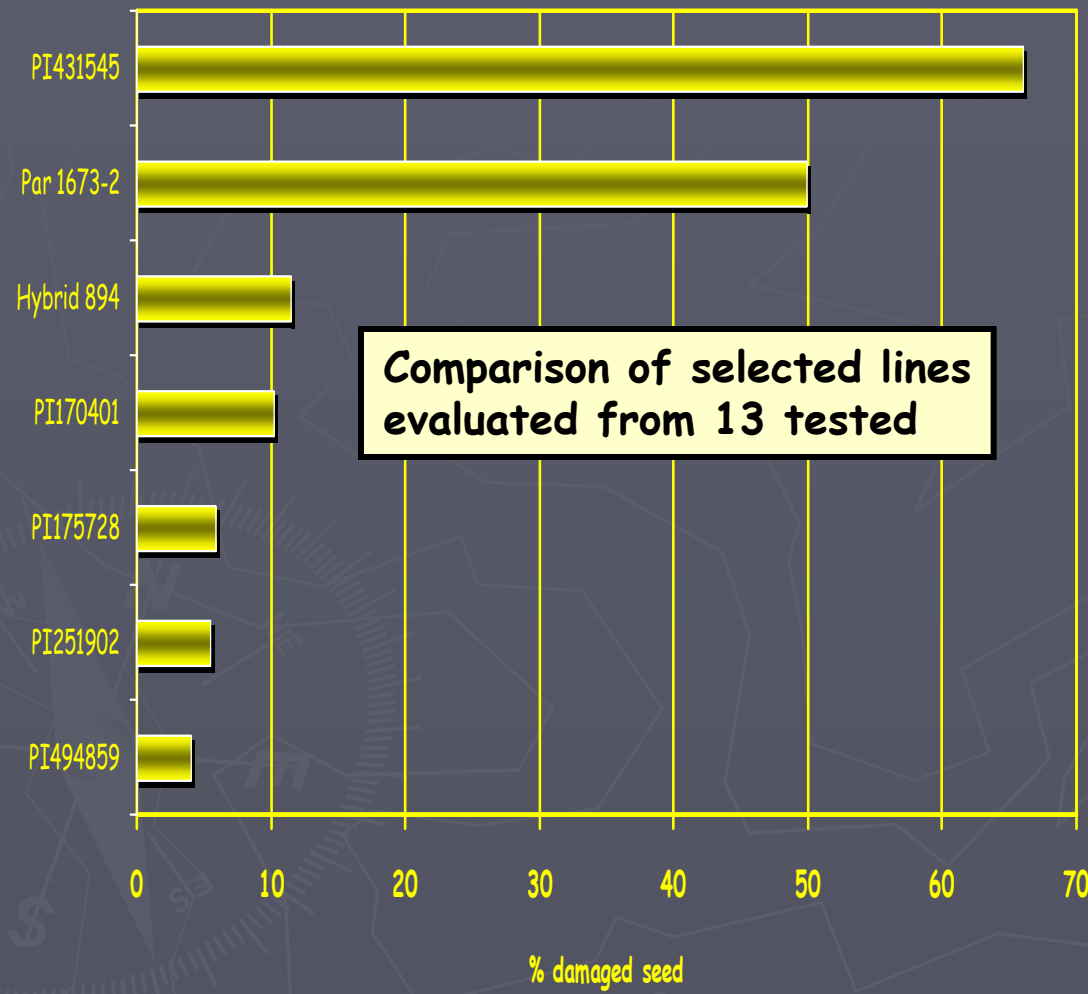
Banded Sunflower Moth Trial 2007



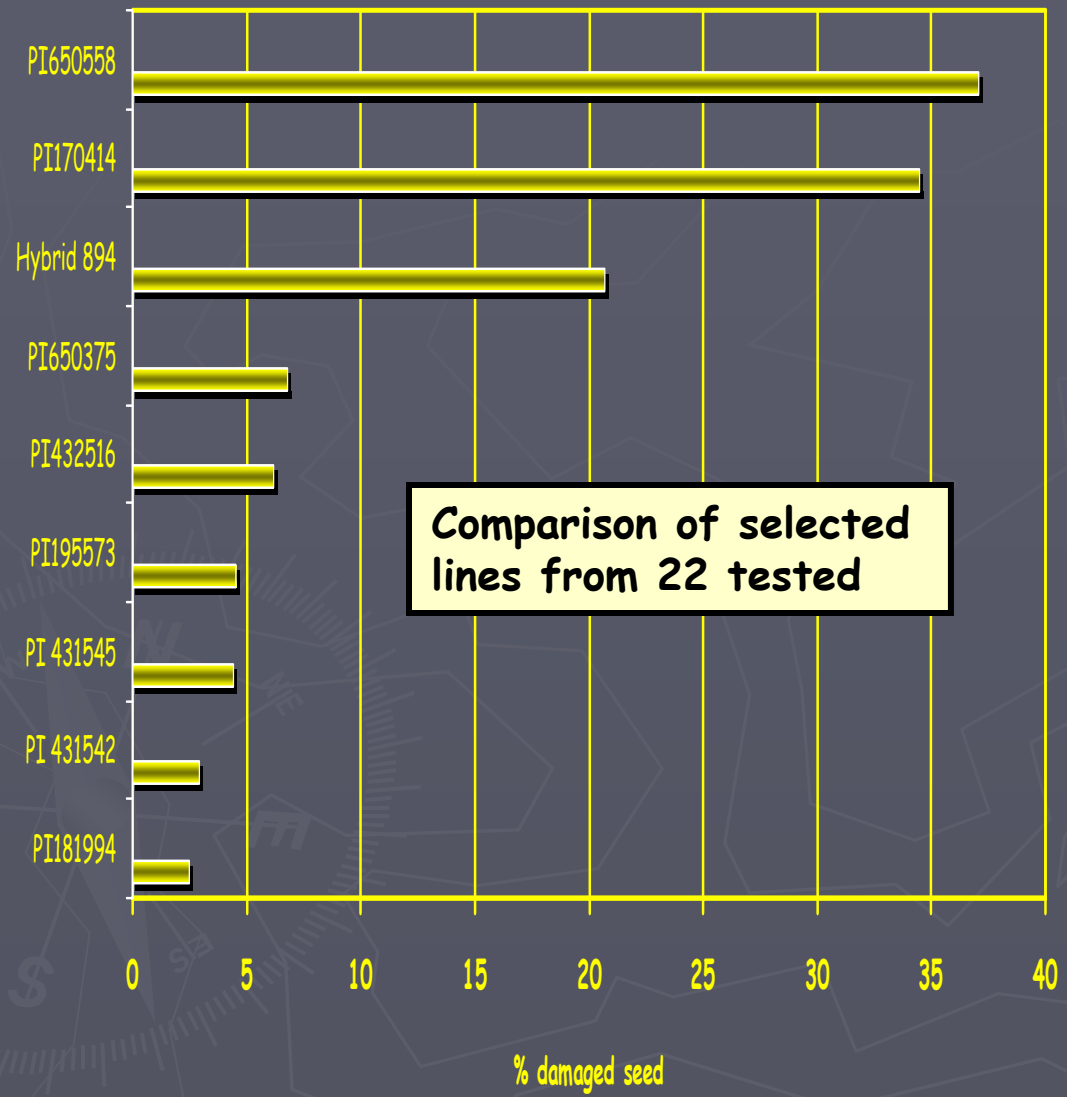
Comparison of selected lines evaluated from 13 tested

S1s trial
32 lines including checks tested
Range 3 to 62% damaged seed
8 with < 15 % damage

Jerry's Crosses trial
66 lines including checks tested
Range 2 to 72% damaged seed
43 with < 20% damage
16 with < 10% damage

Prosper, ND

Red Sunflower Seed Weevil Trial 2007



Comparison of selected lines from 22 tested

S1s trial
36 lines including checks tested
Range 1 to 25% damaged seed
20 with < 10% damage

Jerry's Crosses trial
45 lines including checks tested
Range 0.4 to 21% damaged seed
31 with < 10% damage
13 with < 5% damage

Highmore, SD

Sunflower Midge Trial 2008
Necrosis Index (0-5)

19 hybrids ≤ 1

Low densities of midge, but populations present annually

76 hybrids tested

=4

[5=50% or > of each quadrant with necrosis]

Trial at Mapleton, ND

Conclusions & future directions

Stem weevil, Sunflower moth, Banded sunflower moth & Red sunflower seed weevil

- Promising germplasm was identified from these trials:
  - ✓ lower stem weevil numbers in the stalk in a number of lines
  - ✓ reduced seed injury from attack by the seed weevil & both moths
- Trials were again conducted in 2008. New & retested accessions were evaluated. S_1s and Jerry's crosses ($F_{2:3}$ lines) were retested.
- Accessions determined to be the most resistant will be tested against susceptible checks in 2009.
- The best S_1s from the 3 previous years of testing will be random-mated to begin the next cycle of breeding lines.
- $F_{2:3}$ lines that were tested in 2007 & 2008 were self-pollinated in 2008 and will be evaluated as $F_{3:4}$ lines in 2009. These lines will also be self-pollinated in 2009, which will result in $F_{4:5}$ lines. Test crosses of these lines will be made in 2009 to a single, susceptible R-line tester, which will allow us to begin preliminary hybrid evaluation as early as 2010.