New Virulent Races of Downy Mildew:

Distribution, Status of DM-Resistant Hybrids, and USDA Sources of Resistance to Races that Overcome the PI_6 Gene

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Background

- Sunflower downy mildew exists as many ‘physiological races,’ controlled either by seed fungicides or single, dominant resistance genes.
- In the U.S., 11 races have been identified (2000-2008) from ~ 350 samples processed by the USDA unit.
- Race 730 dominant (42%), and with race 770, comprise two-thirds of all isolates.

Background

- Worldwide, 36 races have been identified, with four dominant (700, 710, 730, 770).
- First race to overcome PI_6 (304) found in France (2000).
- In 8 years, six more “hot” races have been identified in France (307, 314, 334, 704, 707, 714).
- In the U.S., no DM sample has been found that overcomes the PI_6 gene (HA-335) since it was released in 1988.

2009

- ***Bruce Due*** (Mycogen) observes scant amount of plants showing systemic downy mildew symptoms in a field of DM-resistant hybrid.
- Field located near Willow City, ND (Bottineau county).
- ***Mike Hutter*** (crop consultant in Bottineau county) enlisted to survey fields and collect samples.
- Other samples sent in by NSA surveyors, seed company personnel, and collected by the USDA sunflower unit.

First Race to overcome Pl-6

- Willow City, ND:

734

Differential	Reaction	Race Code
Susc	S	7
RHA 265	S	
RHA 274	S	
DM-2	S	3
PM-17	S	
803	*R*	
HAR-4	*R*	*4*
HAR-5	*R*	
HA-335	S	

First Race to overcome Pl-6

- Double-checks –
  - Two seedlots of HA – 335 tested
  - HA-336 (also with Pl-6) tested
  - 100% infection of HA-335, HA-336 and susceptible check
  - Test repeated twice, with same results
  - DM samples from single plants, rather than ‘composite sample’ from multiple plants, show that more than one race present

Second Race to overcome Pl-6

- **714**

Differential	Reaction	Race Code
Susc	S	7
RHA 265	S	
RHA 274	S	
DM-2	S	1
PM-17	*R*	
803	*R*	
HAR-4	*R*	*4*
HAR-5	*R*	
HA-335	S	

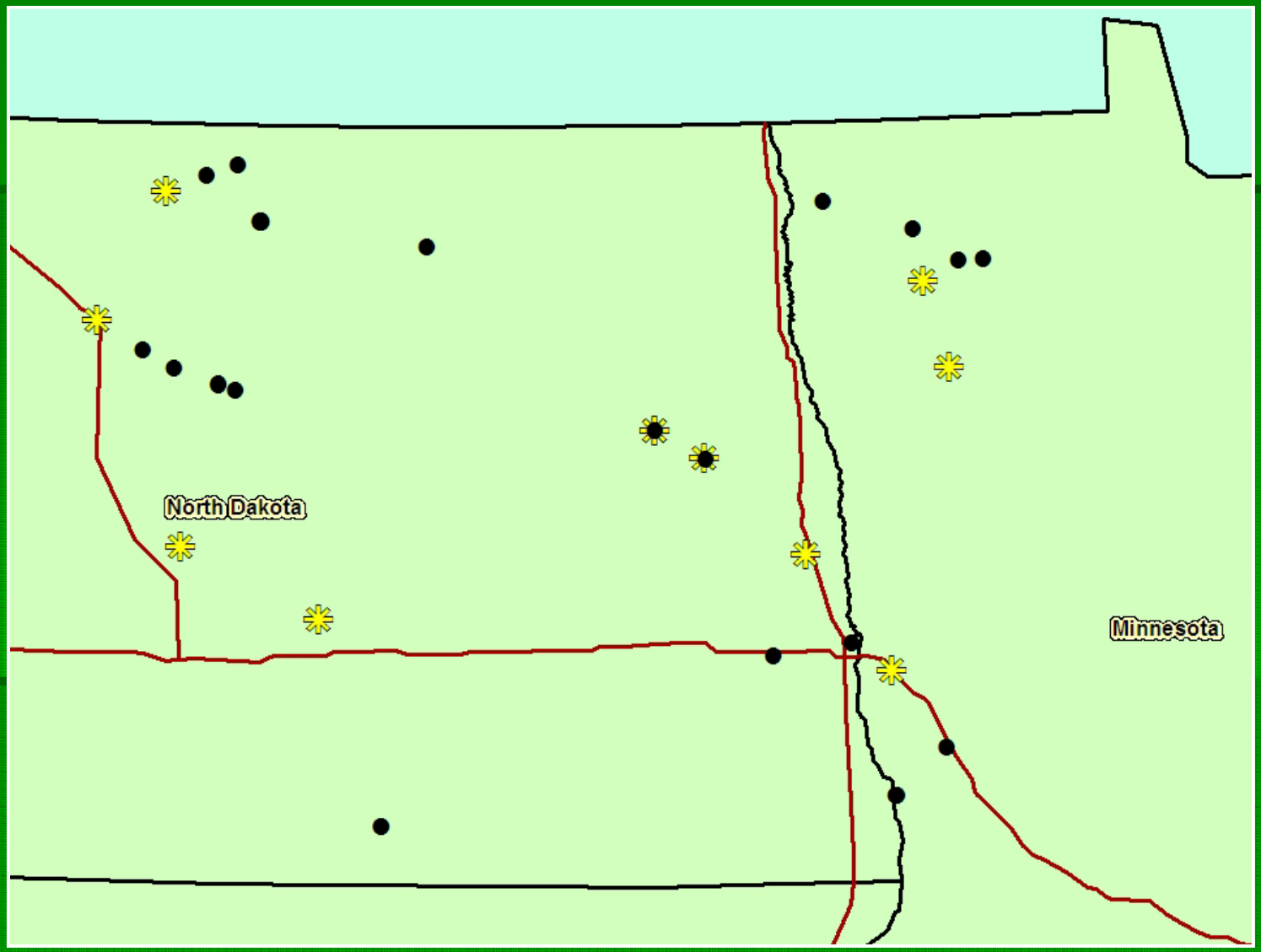
Reaction of Other 'DMR' USDA lines to 10 isolates of new races

	USDA Line	Source of DM genes	Reaction
1	HA-336	*H. annuus* – TX	S
2,3,4	HA-337,338, 339	*H. praecox* - TX	S
5	RHA-340	*H. argophyllus* - TX	R
6,7	HA-419/420	*H. argophyllus* - FL	R
8	HA-428	*H. annuus* - NM	R
9	HA-458	*H. annuus* - ID	R
10	TX-16	*H. annuus*- TX	7 R/ 3 S
11	HA-445	*H. annuus* – TX	S
12	HA-460	*H. argophyllus* – TX	8 S/ 2 R
13	RHA-464	*H. annuus* - CA	S
14	RHA-468	*H. annuus* - NM	S

Distribution of New "Hot" Downy Mildew Races in U.S.

- 49 'viable' mildew samples collected this summer
- ND (31), MN (11), SD (3), NEB (1), OK (1), Canada (2)
- All mildew samples were inoculated onto 9 differentials using standard inoculation, PLUS, inoculated onto HA-335 using a 10X spore concentration (*to detect low levels of a virulent race)*
- ***11 of 49*** samples (22%) were able to infect HA-335 (PI_6 gene)
- *Sampling was not random, and concentrated on areas where hot race was first observed*

Distribution of New "Hot" Downy Mildew Races



Yellow starbursts are hot races. Many of 41 data points overlap.

Mildew Resistance in Hybrids

- Several companies have hybrids on the market listed as “DMR” or mildew resistant.
- 43 hybrids tested from 4 companies (Advanta-10, Croplan – 13, Mycogen – 6, Seeds2000 – 14)
- *Hybrids with PI_6 or PI_7 resistance all susceptible.*
- Hybrids with PI_8 gene challenging to characterize as they appear resistant with 11-day mildew test (*gene allows slight sporulation on cotyledons, but no systemic infection develops*). So test extended to 21 days to observe symptoms on true leaves.
- Some companies use DM-resistance from other than USDA releases.

Mildew Resistance in Hybrids

- Completely ***resistant*** to new races (only 4 companies submitted entries)

Advanta 30236 *

Croplan 305, 325, 369 and 555

Mycogen E87420 *

Seeds2000 (oil): X4840*, X9716*, X9741*, X9746*, X9762*

Seeds2000 (confection): X3247*, X3947*, X9647*

*denotes experimental hybrids not yet marketed

DMR hybrid Reaction to Race 734

- Hybrids marketed as “downy mildew resistant (***DMR***)” but completely susceptible to new races:

  Croplan: 306*DMR*, 343*DMR*, 366*DMR*, 367*DMR*, 803*DMR*, 3080*DMR*

  Seeds2000: Panther *DMR*, 6946 *DMR* and Defender +

  Integra: 536 *DMR*

  Mycogen: 8N337*DMR*, 8N453*DMR*, 8N520*DMR*, 8H288*DMR*, 8H350*DMR*

Summary – 1

- New races able to overcome the Pl_6 gene (HA-335, 336) and the Pl_7 gene (HA-337, 338, 339) were found for the first time in the U.S. – races 714 and 734.
- While observed initially in Bottineau county, ND, the new hot races were found in several ND and MN sites.
- Sampling was not uniform, so estimates were biased. A large scale survey and isolate collection in 2010 is advisable, both in the U.S. and in Canada.

Summary – 2

- Resistance to new races is available in released USDA lines, notably RHA 340, RHA 419/420, HA 428 and HA 458.
- Expanding the potential pool of resistance genes by exploring wild *Helianthus* is advisable, and transferring genes into elite germplasm combined with other traits will be a unit objective.
- Fungicide seed treatments (IDOL and DYNASTY) as effective on new hot races as to previous races.

Summary – 3

- Many commercial hybrids marketed as “DMR” are now susceptible to the new race.
- However, experimental and marketed hybrids are available (oil & confection) which continue to exhibit resistance to all ‘current’ mildew races.