Advances in Managing Sclerotinia Stalk Rot of Sunflower with Resistant Hybrids

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Abstract

Sclerotinia sclerotiorum, commonly referred to as "white mold," continues to be the most serious pathogen affecting sunflower in the United States, and poses a double threat as it incites both a head rot and a stalk rot. In 2005, head rot and stalk rot were observed in 28% and 25% of fields inspected in six states, and affected 1.6% and 2.3% of the crop, respectively. Thus, in 2005, the relative impact of stalk rot and head rot were comparable, in contrast to previous years in which head rot was much more prevalent.

For the second year, commercial hybrids were screened for both head rot and stalk rot resistance in multiple locations, with support coming from the USDA Sclerotinia Initiative. A total of 85 hybrids, plus four checks, were grown at five locations and artificially inoculated with Sclerotinia. Three locations produced statistically sound data, with the 85 hybrids ranging in stalk rot incidence from 8% to 71%, averaged over the three locations. The USDA hybrid HA 409 x RHA 412 was the most resistant entry. Stalk rot incidence exhibited a continuous range from most resistant to most susceptible, as would be expected with a quantitative, polygenic trait. Twenty-eight of the 85 hybrids were statistically no different than HA 409 X RHA 412, with stalk rot ranging from 12 to 26%. Of this highly resistant group, 15 of the 28 hybrids are on the market, with the remainder being experimentals. The most resistant entries in both the head rot and the stalk rot trials will be tested in 2006 at multiple, inoculated plots to provide reliable information on disease resistance across multiple environments.

Introduction

In an effort to accurately determine the level of resistance to Sclerotinia stalk rot in commercial sunflower hybrids, the USDA Sunflower Research Unit has coordinated multiple locations of inoculated field plots with help from several seed companies and funding from the USDA Sclerotinia Initiative. This effort has been coordinated with the head rot evaluation program, which is headed by Bob Henson of the North Dakota State University Carrington Research Extension Center (Henson et al., 2006). The results of these trials, after statistical analysis, have been published in the annual review of sunflower hybrid yield trials compiled by North Dakota State University (Berglund and Grady, 2005) and have been posted on the website of the National Sunflower Association (http://www.sunflowernsa.com/uploads/HybridDiseaseRatings_05.pdf.).

Materials and Methods

A total of 70 hybrid entries were solicited from 15 seed companies for initial testing in 2005. In addition, 15 hybrids which performed well in either the head rot or stalk rot trials in 2004 were retested in 2005, bring the total number of entries to 85. Seed companies were requested to submit a maximum of seven entries, with two of the entries being hybrids already on the market. Seeds of all entries were "over treated" with the fungicides fenamidone and zoximide (63 and 125 g ai, respectively/100 kg seeds) to provide optimal protection against downy mildew in an effort to establish uniform stands. Test locations in 2005 were Carrington, ND (NDSU Research Extension Center), Mapleton, ND (Interstate Seeds), Grandin, ND (CHS), Breckenridge, MN (Mycogen) and East Grand Forks, MN (Cenex Land O'Lakes). Experimental design at each location consisted of planting each hybrid in single-row plots 7 m long on 75 cm centers, with four replications, in a randomized complete block layout. The resistant check, NK 277, was included twice in each replicate (for a total of 8 plots/location) and the susceptible check, Cargill 270, was included four times per replicate (for a total of 16 plots/location). All five locations were planted between May 24 and June 1, 2005.

Sclerotinia inoculum was produced by growing the fungus on autoclaved white proso millet for ~7 days (before any sclerotia developed), drying the inoculum to 10% moisture, and storing it at 4 C until needed. Using a granular chemical applicator (Gulya et. al, 2005), the inoculum was placed in a furrow ~ 25 cm from each row, about 8 to 10 cm deep (Figure 1). Each 7 m row received ~ 40 to 50 g of inoculum. For each 1000 rows, we used approximately 60 kg. or 135 pounds of millet-based inoculum. Each location was inoculated 5 to 6 wk after planting when the plants were approximately at the V-6 stage, or no more than 45 cm tall, which permitted using the tractor-drawn inoculator with minimal damage to the plants. Plots were evaluated for disease incidence at least twice, with the first evaluation in late August (12 to 14 wk after planting, or 7 to 9 wk after inoculation), and the second evaluation two weeks later. A plant showing wilt and/or a basal stalk rot lesion was recorded as diseased, and the percent of diseased plants was calculated. Statistical analysis was done using SAS.

Figure 1. Granular chemical applicator mounted with anhydrous ammonia shanks used to deliver millet-based Sclerotinia inoculum in furrows beside sunflower rows at V-6 stage.

Results

Three of the five inoculated stalk rot locations yielded usable information. The Breckenridge MN plot was flooded soon after planting and the stands were too low and erratic for disease evaluations. The Grandin ND plot was similarly flooded at planting and one entire replication was lost. The plot, which was inoculated, also had flooding right after inoculation which both reduced disease incidence and led to non-significant differences between hybrids. The remaining three stalk rot locations (Carrington, East Grand Forks and Mapleton) had statistically valid data and average disease incidences ranging from 8 to 71% (Table 1). Statistical separation of hybrids was valid at both evaluation dates, but the range of disease incidence, as expected, was highest at the last evaluation date. A comparison between a highly resistant and highly susceptible hybrid is depicted in Figure 2.

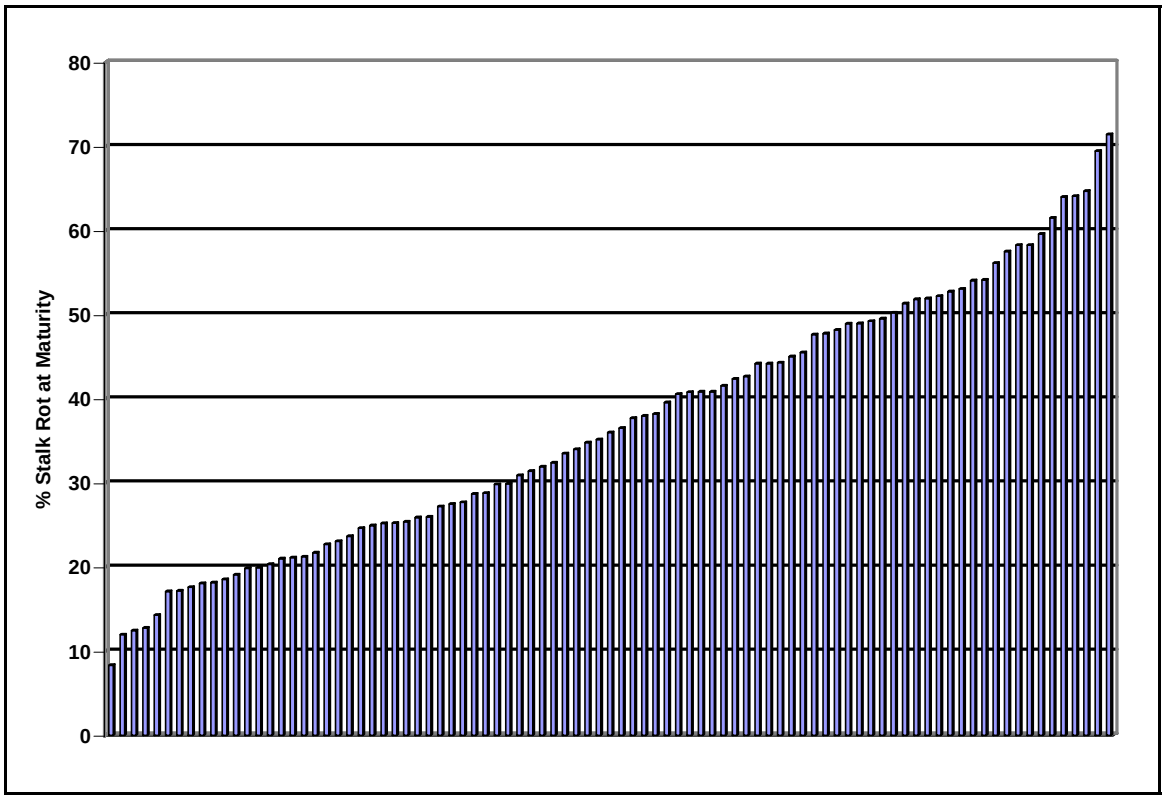
Table 1. Summary statistics for Sclerotinia stalk rot incicence on hybrids at three inoculated plots in 2005.

	Average, over 3 locations	Location		
		Carrington	Mapleton	East Grand Forks
Average	38	50	25	41
Minimum	8	7	1	5
Maximum	71	92	63	87
c.v.	57	40	66	66
Lsd, 0.05	17	28	23	37

Figure 2. A comparison between an entry (left) highly resistant to stalk rot and a highly susceptible entry (right) in the inoculated trial at Carrington, ND.

The gradation in disease incidence from the most resistant to the most susceptible hybrids was continuous, as would be expected from a polygenically controlled quantitative trait, which precludes categorizing the entries into discrete groupings such as “resistant” or “susceptible.” (Figure 2).

Figure 2. Histogram showing the stalk rot incidence of 85 sunflower hybrids, averaged over three locations in 2006.



The most resistant entry, averaged over three locations, was the USDA hybrid HA 409 x RHA 412, at 8% stalk rot. Twenty-eight entries were not statistically different, at the 5% level using Duncan's multiple range test, from the USDA check (Table 2). Seventeen of these hybrids were released hybrids, and thus are currently available to growers who wish to plant more resistant hybrids. Only one of the entries was a confection hybrid, but Seeds2000 Bigfoot was the third most resistant entry among all 85 hybrids.

Table 2. Stalk rot ratings of entries not significantly different from the resistant check, HA 412 x RHA 409, in the 2006 inoculated trials at East Grand Forks (EGF), Carrington (Carr) and Mapleton (Mapl). Yellow highlighted hybrids are released, while the remaining hybrids are experimental hybrids.

	Average	Rank	EGF	Carr	Mapl
USDA HA412XRHA409	8.3	*1*	9	12	4
Heaton MTH2	12.0	*2*	17	4	16
Seeds2000 Bigfoot	12.5	*3*	26	7	5
Cropland 343	12.8	*4*	9	21	9
Seeds2000 X4625	14.3	*5*	25	17	1
CHECK Northrup King 277	17.1	*6*	26	13	13
Monsanto 35-10NS	17.2	*7*	20	6	25
Kaystar EX2453	17.6	*8*	17	30	6
INRA XRQ x PSC8	18.1	*9*	19	19	17
Triumph TRX 3241	18.2	*10*	15	27	13
Mycogen E85419	18.5	*11*	20	22	14

Interstate 4704NS	19.1	12	25	22	11
Interstate Hysun 525	19.9	13	29	18	12
Seeds2000 X4794	19.9	14	5	39	16
Mycogen 8N510	20.3	15	35	14	12
Advanta AP431NS	21.0	16	15	20	28
Interstate 4540NS	21.1	17	24	24	16
Legend Seeds LSF 126N	21.2	18	29	8	27
Cropland 304	21.7	19	29	2	34
Advanta AP422	22.7	20	31	22	15
Heaton MTH1	23.1	21	23	6	41
Proseed 9405	23.7	22	28	17	26
Garst 4690	24.6	23	20	32	22
Dyna-Gro EX 92H06	24.9	24	35	31	10
Cropland 2NS004	25.2	25	46	22	8
Interstate Hysun 450	25.2	26	31	7	38
Dyna-Gro 93N05	25.4	27	17	47	12
Advanta AP461NS	25.9	28	32	37	9
Kaystar 9404	26.0	29	37	32	9
CHECK Cargill 270	54.1	78	60	67	35

The performance of the best entries from the 2004 trials, along with the resistant and susceptible checks, are shown in Table 3. In 2004, some entries were tested only for stalk rot or only for head rot, and thus data for some entries is unavailable for both years. For entries tested in both years, there was a total of three trials for head (one in 2004, two in 2005) and six trials for stalk rot (three trials in each year). Of the limited number of entries tested in both years, the hybrids which had the lowest incidence of head rot and stalk rot were Interstate's Hysun 450 and 4540 NS, Monsanto 35-10NS, and ProSeed 9405, and all of these are commercially available hybrids. The best entries from the 2005 trials will similarly be retested in inoculated trials in 2006 for both head rot and stalk rot. With the expanded head rot trials forecast for 2006, there will be up to five head rot and eight stalk rot locations for these "retests" over the two year period.

Table 3. Ratings of entries tested over two years in inoculated trials for reaction to Sclerotinia head rot and Sclerotinia stalk rot (ratings in % affected plants at maturity.

	Head Rot				Stalk Rot			
Entry	2004	2005	2-yr average	2 yr Rank	2004	2005	2-yr Average	2-yr Rank
Cargill 270	62	67	64.6	11	73	54	63.6	11
CHS RH318	63	71	66.8	12	72	45	59.0	10
Croplan CL135	NT	64			32	32	32.2	8
IS 4540 NS	47	34	40.3	8	24	21	22.6	5
IS Hysun450	43	34	38.4	7	17	25	20.9	3
Legend LSF126N	37	44	40.3	9	NT	21		
Mycogen 8N510	NT	52			19	20	19.6	1
Monsanto 35-10NS	37	28	32.7	6	25	17	21.1	4
Mycogen 8N352	NT	58			27	35	31.3	7

NK 277		20	25	22.7	1		22	17	19.6	1
ProSeed 9405		21	32	26.3	3		34	24	28.6	6
ProSeed C9011		42	47	44.7	10		36	41	38.3	9
Seeds2000 X4794		20	39	29.6	5		NT	20		
Seeds2000 X936		33	25	29.2	4		NT	58		
Seeds2000 X978		24	25	24.7	2		NT	64		
USDA Exp. Hybrid Check		NT	40				NT	8		

Discussion

For the second year, we have successfully generated data on a large group of experimental and released commercial hybrids for their reaction to Sclerotinia stalk rot, using a mechanized inoculator to induce a moderate amount of disease which allows statistical separation of the hybrids. These same entries were tested for head rot in one inoculated trial, under mist irrigation, at Carrington, and were also evaluated for midge resistance. This data is being made available to both seed companies, giving them accurate data to help advance experimental hybrids to the market, and to growers, allowing them to make informed hybrids selections, based on yield and disease reactions.

Literature Cited

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