Changes in Sunflower Disease Incidence in the United States During the Last Decade

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Abstract

Changes in sunflower disease incidence, severity, and distribution from 1984 through 1995 in the north central region of the United State were moitored through periodic surveys. While Phoma black stem was consistently the most prevalent disease, it was not considered economically serious unless it was compounded with drought stress and/or stem weevil damage. Sclerotima wilt (dasal stalk rot), observed in about half of inspected fields in each survey, continues to be the most serious disease in the area, and has been little affected by climate fluctuations. In contrast, the incidences of rust and Sclerotinia head rot have shown dramatic swings during the past decade, with rust being severe during the hot, dry seasons of 1988—1991, and Sclerotinia head rot becoming increasingly more prevalent during the wetter than average summers of 1992—1995, Phomopsis stem canker has increased slowly over the last decade until it may be the second most serious disease in the nouth central production area. In 1995. Phomopsis stem canker was found in 80% of the fields and affected 17% of the crop.

Key words: Sclerotinia, Phomopsis, Phoma, Plasmopara, Puccinia

Materials and Methods

Disease surveys examining all sunflower diseases were done in 1984, 1991, and 1995. In 1984, 160 fields in the major sunflower producing counties of North Dakota (ND), South Dakota (SD) and Minnesota (MN) were visited in Spetember. The surveyed counties contained about 90% of the sunflower production in the tri-state area and thus were representative of the growing conditions. In 1991, 109 ND fields were surveyed in September, when most plants were at physiological maturity. In September, 1995, 79 fields in ND, SD and MN were inspected. Two additional surveys were conducted during the last decade. During the period 1990—1993, samples of downy mildew (*Plasmopara halstedii*) were collected in ND specifically to determine race frequency and distribution. A second survey, done in

1989/1990, collected rust (*Puccinia helianthi*) samples in ND, SD and MN, again to determine the race frequency. The percent of leaf area covered by rust pustules was estimated using the diagrams of Gulya et al., (1990). Leaves bearing spores of either downy mildew or rust were collected from individual plants and increased on a universal suscept in the greenhouse. Downy mildew samples were inoculated onto differential lines IS-003, RHA 265, RHA 274, DM-2, IS-200, and HA-335 (Gulya et al., 1991; Gulya, 1996b). Rust samples were inoculated onto a universal suscept and differential lines MC-29, CM-90 and HAR-5 initially, with the subsequent addition of lines P-386, HAR-1, HAR-2, HAR-3, and HAR-4 (Gulya and Masirevic, 1996).

The actual inspection procedures varied from year to year as experience was gained and new procedures tested and later modified. In every year two inspectors visited each field and took notes with the aid of preprinted forms listing every disease. Diseases to be recorded included Sclerotinia wilt, Phoma black stem, downy mildew, Phomopsis stem canker, Verticillium wilt, head rots (*Sclerotinia*, *Rhizopus*, *Botrytis* recorded separately), rust, Alternaria leaf blight, and any other diseases. When diseases could not be identified in the field based on symptoms, samples were collected, brought back to the laboratory for culturing, and in some cases, completion of Koch's postulates. In the 1984 survey, five strips of 50 plants were inspected per field by each person, for a total of 500 plants per field. Both the number of plants affeted by each disease, and the severity, was recorded. For the purposes of this report, only disease incidence will be described. In subsequent surveys each of the two surveyors inspected four groups of 30 plants apiece while walking an inverted-W path through the field, for a total of 240 plants per field.

Results and Discussion

1984 *Survey*. The predominant diseases observed in ND, SD and MN were Phoma black stem, downy mildew, Sclerotinia wilt and Alternaria leaf blight, being found in 73, 59, 48 and 48% of fields, respectively (Gulya and MacArthur, 1984). Despite being the predominant pathogen, Phoma was not considered to be economically serious unless stem weevil (*Cylindrocopturus adspersus*) oviposition and larval tunneling spread the fungus inside the stem. Downy mildew was found in 59% of fields, an increase from the 23% and 49% observed in 1981 and 1983. Downy mildew affected 1% of all plants and 3% of fields had $>25\%$ mildew-infected plants. Sclerotinia wilt was found in 48% of fields, an increase from 32% observed in 1979 (Gulya and Jons, 1981). Wilt, while the third most predominant disease, was regarded as the most economically damaging disease, affecting 3% of all plants. Sclerotinia wilt severity was greatest in the eastern half of ND, with some fields having up to 60% infection, and this coincided with areas having the greatest concentration of other host crops

(i. e. *Glycine max*, *Phaseolus vulgaris*). Although Alternaria leaf blight (caused by *A. helianthi primarily*) was present in 49% of fields, and rust in 29%, neither disease was considered economically important. The primary factor limiting the severity of foliar diseases and precluding the appearance of Sclerotinia and other head rots was the scarcity of rainfall during anthesis in most of the growing area. Some of the minor diseases observed in 1984, with incidences in parenthesis, included powdery mildew (caused only be *Erysiphe cichoracearum*) (12%), head rot (caused primarily by *Rhizopus spp.*) (5%), Sclerotinia mid-stalk rot (4%), and Phomopsis stem canker (0. 06%). Noticeably absent in inspected fields were Septoria leaf blight, Verticillium wilt, charcoal rot (*Macrophomina phaseolina*), Botyrtis head rot, apical chlorosis (*Pseudomonas syringae* pv. *tagetis*), and any viral disease.

1991 *Survey*. Phoma black stem was again the predominant sunflower disease, found in every field and affecting 78% of all plants (unpublished data). It was not considered economically damaging because on most plants the lesions were superficial, non-girdling, and usually <2cm long. In contrast to 1984, rust was the second most prevalent disease, found in 81% of fields and affecting 52% of plants. Sclerotinia wilt continued to be significant, found in 46% of fields. Sclerotinia head rot occurred in 17% of fields in 1991, but affected only 0. 2% of plants. In 1986, Sclerotinia head rot was extremely serious due to excessive rainfall during anthesis, and head rot affected 10% of the ND crop (Gulya et al., 1986). Rhizopus head rot, while common in 1984, was observed in only 1% of fields in 1991. Downy mildew was observed in 16% of fields in 1991, but affected only 0. 05% plants, in response to the widespread use of metalaxyl seed treatment, which gained a federal label in 1985. Verticillium wilt was recorded in 12% of fields, affecting 0. 3% of plants. The incidence of Phomopsis stem canker increased from 0. 06% in 1984 to 6% of fields, but still only affected 0. 05% of plants. There was a significant positive correlation between Sclerotinia wilt, Sclerotinia head rot and downy mildew incidences, suggesting that fields with these diseases had previous disease histories and inadequate, short rotations. The correlation between Sclerotinia wilt and head rot incidence suggests that in many instances the airborne inoculum for head rot infection originated from within a sunflower field where overwintered sclerotia germinated both mycelogenically and carpogenically. Diseases not recoreded again included charcoal rot, apical chlorosis, and any viral disease. Powdery mildew, Alternaria leaf blight and bacterial leaf spots were not recorded because they were all considered insignificant in 1991.

1995 *survey*. Phoma black stem was again the most predominant disease in the rei-state area, found in 94% of fields nad affecting 61% of plants (Gulya, 1996a). The significance of Phoma infection was again considered minimal. In contrast, Phomopsis stem canker escalated dramatically and was observed in 82% of fields, affecting 17% of plants. The most

severely affected area was northwestern MN, where extensive lodging was observed. The incidence of Sclerotinia wilt remained steady, at 53% of fields, but Sclerotinia head rot increased to 37% of fields. The two Sclerotinia diseases affected 2% and 3% respectively. Downy mildew was found in 18% of fields, but affected only 0. 03% of plants, while rust incidence decreased dramatically to only 5% of fields.

Downy mildew surveys. Downy mildew became increasingly diffcult to find as the practice of treating seed with metalaxyl became mor prevalent, so samples for DM race identification were collected primarily from breeding nurseries rather than commericial fields. Twenty-five locations were sampled over a three-year period, yielding 297 isolates (Garcia and Gulya, 1991; unpublished data,). Race 4, defined as being virulent on RHA 265, RHA 274, DM-2 and IS-2000, but avirulent on HAR-4 and HA-335, was the most frequently observed virulence pattern, comprising 73% of all isolates. Race 3, which is virulent only on RHA 265 and RHA 274, comprised 18% as the second most common race. The remaining 9% of isolates were classified as races 2, 5, 7, 8and 9. No samples of races 1 or 6 were recovered. Rashid (1993) observed a similar pattern in Canada, but race 3 was the major race, observed in 42 to 45% of fields, and race 4 was the second most widely recovered race. His observations documented that many field collections were not pure races but rather mixed samples of several races.

Rust Surveys. During the 1989 and 1990 growing seasons, 127 samples of rust were collected from commercial fields (Gulys, 1990). Rust was pressent in 88% of surveyed fields in the tri-state area, compared to 29% in 1984 and 5% in 1995, In both 1989 and 1990 race 3 was the predominant race, comprising 77% of all isolates. In 1988 race 4 was the only other race identified, while in 1989 race 4 comprised only 4%, with the remaining 19% being new races able to infect one or more of the HAR lines. Thus in the north central area of the U. S. A., a major shift in the rust population occurred, with race 3 now the major component. Race 1 and 2, the major races found during the 1950-1980 period (Sackston, 1962; Zimmer and Rehder, 1976), were not detected at all in the 1989/1990 surveys. Rashid (1991) observed a similar preponderance of race 3 in Canada, as well as many new virulence patterns, which he classified as subgroups of race 3 and 4, based on their virulence on one or more HAR lines His observations documented the need to use all five HAR lines as differentials, despite the fact that they bad all been selected for resistance to the original four races identified by Sackston. Rust collected predominantly from wild *Helianthus* spp. in the central and southcentral states of Kansas, Colorado, Texas and New Mixico revealed the presence of many virulence patterns not known to exist in the tri- state area (Gulya and Viranyi, 1994). While race 3 rust is also the major race in this area, more than a dozen additional virulence

patterns were found, including isolates which were able to infect all nine differentials.

Conclusions

A glance at Table 1 reveals that some diseases affecting sunflower production in the north central area of the United States, such as Sclerotinia wilt, have remained particularly stable over the last decade, despite weather fluctuations during the growing season. The continued high incidence of Sclerotinia wilt in the northen growing region of the U. S. A. is due to several factors, including short rotations with other *Sclerotinia*-susceptible crops, the lack of resistant hybrids or other control options. and the relative insensitivity of *Sclerotinia* to weather as it influences root infection. In contrast to Sclerotinia wilt, other diseases, such as Sclerotinia head rot and rust, have fluctuated up and down in incidence, largely in response to changing weather. Rainfall amounts in the tri-state ares during the four-month growing season has varied from approximately 250 mm to 2000 mm, which has had a profound effect upon airborne pathogens' ability to infect sunflower leaves and heads. The incidence and severity of Sclerotinia head rot is directly correlated with the amount of rainfall in the month of August, during which most of the crop in the tri-state area is at the bloom stage. In contrast, rust does not appear as dependent upon rainfall, as overnight dews provide sufficient moisture for infection. With rust, the primary factor resulting in epidemics in the 1988-1991 period was a shift in rust races (coupled with a lack of resistance in hybrids) and warmer than normal summer, leading to short rust generation times and increased urediospore production. Downy mildew, once of serious concern in the U. S. A. while new races were being dirscoverd, has decreased to a consistent low incidence and is now of minor importantce, primarily because of widespread use of metalaxyl seed treatment. While over a dozen DM races have been indentified in the U. S. A., races 3 and 4 make up over 90% of the isolates. Since no U. S. commercial hybrids are resistant to both DM races 3 and 4, use of fungicide-treated seed is the best protection against downy miledw. Phomopsis stem canker presents a unique case study for disease development. In the early 1980's *Phomopsis helianthi* was probably only present in trace amounts and/or in scattered locations. Disease incidence was probably not limited by lack of suitable weather conditions. Over the intervening decade, the fungus became more sidespread but did not reach levels that were noteworthy, primarily becauste of the drought conditions during the 1988-1991 period, When weather patterns changed in the early 1990's, specifically with higher rainfall amounts, Phomopsis stem canker was found throughout the tri-state growing region, and in some areas scaused significant yield losses due to defoliation and lodging. On a positive note, there are many diseases which continue to be of minor signficance for the crop in the northern growing areas. These include Verticillium wilt, Alternaris, Septoria and bacterial leaf blights, and head rots caused by *Rhizopus and Botrytis*, Additionally, there are a number of diseases

which have never been confirmed on northern-grown sunflowers, including charcoal rot , root rots caused by *Sclerotinia minor* and *Sclerotium rolfsii*, rusts caused by *Puccinia xanthii* or *Coleosporium helianthi*, viral diseases, and white rust (*Albugo tragopogonis*).

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Table1. Changes in incidence (% of fields with disease)and severity(% plants affected)for selected sunflower diseases in the northern production area of North Dakota, South Dakota, and Minnesota during the last decade.

Disease	1984	1991	1995
Downy mildew	60(1)	16(0.05)	18(0.3)
Sclerotinia wilt	48(3)	46(2)	53(2)
Rust	29(0.3)	81(52)	5(2)
Sclerotinia Head Rot	5(0.2)	17(0.2)	37(3)
Phomopsis stem canker	0.6(.001)	6(0.05)	82(17)