Diseases of Sunflower in California

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ABSTRACT

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Sunflower seed production has shifted from the north central states of North Dakota and Minnesota to California, primarily because of the longer growing season, but also to escape disease and insect problems of the Midwest. Between 1983 and 1988, the most prevalent diseases observed by county agricultural inspectors on sunflower in California were Rhizopus head rot (caused by *R. oryzae*), powdery mildew (caused by *Erysiphe cichoracearum*), and charcoal rot (caused by *Macrophomina phaseolina*), none of which are diseases of quarantine significance. Rust (caused by *Puccinia helianthi*) and Sclerotinia sclerotiorum wilt were the only quarantine diseases observed and these only sporadically. An intensive survey during 1989 detected Rhizopus head rot in 71% of surveyed fields, rust in 30%, powdery mildew in 25%, Sclerotinia sclerotiorum wilt in 20%, Sclerotinia minor wilt in 11%, charcoal rot in 8%, and Sclerotium rolfsii wilt in 6%. Downy mildew (caused by *Plasmopara halstedii*) was detected for the first time in 11 yr in California in one field during the unusually cool spring of 1989. Diseases that were not observed on cultivated sunflower in California include Phomopsis stem canker (caused by *P. helianthi*), Phoma black stem (caused by *P. macdonaldii*), Verticillium wilt (caused by *V. dahliae*), bacterial leaf spot (caused by *Pseudomonas syringae* pv. *helianthi* and *P. cichorii*), apical chlorosis (caused by *P. syringae* pv. *tagetis*), Septoria leaf spot (caused by *S. helianthi*), Alternaria leaf spot (caused by *A. helianthi* and *A. zinniae*), and broomrape (caused by *Orobanche cumana* and *O. ramosa*).

Sunflower production in the United States has increased dramatically in the last 15 yr from 230,000 ha, centered mostly in North Dakota, Minnesota, and South Dakota, to a high of 2.25 million ha in 1979. Current production has plateaued around 1 million ha, with North Dakota having 75% of the total U.S. production area. Production of hybrid sunflower planting seed was formerly centered in the Midwest, with 92% of the certified sunflower seed in 1979 grown in North Dakota and Minnesota (3). Because of the short growing season, variable rainfall, and disease and insect problems in North Dakota and Minnesota, sunflower seed production has shifted almost entirely to California and Texas. In 1988, the latter two states accounted for 57 and 39%, respectively, of the U.S. certified sunflower seed production, whereas North Dakota and Minnesota comprised the remaining 4% (13).

California production is all within the Sacramento Valley counties of Butte, Colusa, Glenn, Solano, Sutter, Tehama, and Yolo, with >90% concentrated in Glenn, Solano, and Yolo counties. With less than 10 cm of rainfall during the April–November period and its long growing season, California's Sacramento Valley has an ideal climate for seed production of many field and vegetable crops, because of a minimum of disease and insect problems. A disease survey of California sunflowers was conducted in the early 1970s before the large increase in sunflower seed production (10). Our objective was to update and provide a current picture of the diseases observed on sunflower in California and their significance.

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MATERIALS AND METHODS

Sunflower seed production fields in the Sacramento Valley counties of Butte, Colusa, Glenn, Solano, Sutter, and Yolo and commercial confection fields in Solano and Contra Costa counties were inspected from 1983 to 1988 for quarantine diseases by county agricultural inspectors. Confirmation of field identification was made by a supervising plant pathologist or the Analysis and Identification Laboratory (California Department of Food and Agriculture or CDFA) in Sacramento. Sunflower fields were inspected during the late vegetative period to detect downy mildew or virus symptoms and again at full bloom through seed maturity for all diseases. Field inspections were conducted according to protocol established by the CDFA (1). Inspectors walked every eighth row or made a variable number of passes through the field, depending on its size, ranging from six passes for a 0.4-ha field to 36 passes for fields 32–65 ha in size. This procedure has been calculated to provide a 95% confidence level in detecting an infection level of 0.1% (1).

During the 1983–1988 period, 1,100 fields of certified seed were inspected. Fields inspected for phytosanitary certification were examined only for pests of quarantine significance to foreign countries. Only disease presence or absence was noted; no quantitative data on disease severity or incidence were collected. Diseases of quarantine significance to foreign countries include: Phoma black stem (caused by *P. macdonaldii* Boerema), downy mildew (caused by *Plasmopara halstedii* (Farl.) Berl. & De Toni in Sacc.), Phomopsis stem canker (caused by *P. helianthi* Munt.-Cvet. et al), bacterial leaf spot (caused by *Pseudomonas syringae* pv. *helianthi* (Kawamura) Young et al and *P. cichorii* (Swingle) Stapp), rust (caused by *Puccinia helianthi* Schwein.), Sclerotinia head rot (caused by *S. sclerotiorum* (Lib.) de Bary), Septoria leaf spot (caused by *S. helianthi* Ellis & Kellerm.), Verticillium wilt (caused by *V. albo-atrum* Reinke & Berthier and *V. dahliae* Kleb.), any virus disease, and broomrape (caused by *Orobanche cumana* Wallr.). Sclerotinia wilt and head rot and rust were added to the quarantine list in 1987.

Sunflower fields were surveyed by D. M. Woods in 1989 for the incidence of all diseases. Eighty-seven sunflower fields, comprising 1,780 ha or nearly one-third of the state's production area, were inspected in Butte, Glenn, Solano, and Yolo counties during August (full bloom growth stage) with the inspection procedures defined by the CDFA. Disease incidence (percentage of plants with disease symptoms in each field) was scored on a 0–4 scale where 0 = disease absent, 1 = trace to 1%, 2 = 2–10%, 3 = 11–50%, and 4 = >50% of the plants affected. The average disease incidence was calculated by multiplying the number of fields in each category by the midpoints of the category. Diseases were identified on the basis of field symptoms, except for diseases caused by sclerotial fungi, which were confirmed by the

CDFA Analysis and Identification Laboratory. Samples of rust and downy mildew were identified to race by T. J. Gulya in Fargo, ND, by inoculating mildew and rust differential sunflower lines in greenhouse tests (6,7). No attempt was made to evaluate yield losses.

RESULTS AND DISCUSSION

The 1989 field survey confirmed the previous report (10) that Rhizopus head rot (caused by *R. oryzae* Went & Prinsen Geerligs) was the most common sunflower disease in California, occurring in more than 70% of seed production fields (Table 1). The disease was frequently associated with feeding by larva of the sunflower moth (*Homeosoma electellum* (Hulst.)), as was observed previously (9), and can thus be managed by controlling insect damage (11). Whereas most surveyed fields had <1% plants affected, 9% of surveyed fields had 11% or more of the heads affected (Table 1). Neither *R. stolonifer* (Ehrenb.:Fr.) Vuill. nor *R. arrhizus* A. Fischer, both found on sunflower in Texas and Minnesota (18), have been identified on sunflower in California.

Powdery mildew (caused by *Erysiphe cichoracearum* DC.) was the second most prevalent disease in 1989 and was consistently observed every year between 1983 and 1988. The disease does not appear until after flowering when the lower leaves start to senesce and does not appear to affect seed production. *Leveillula taurica* (Lév.) G. Arnaud, causal agent of a powdery mildew reported on sunflower in Iraq (14), has been observed on cotton in California but not sunflower (2).

Rust was not commonly observed in seed production fields in the Sacramento Valley during 1983–1988 but was frequent in commercial confection fields in the Sacramento River delta area of Contra Costa County. Because it was not on the list of quarantine diseases until after 1987, no records were kept of its earlier prevalence. The Contra Costa production area, situated on small islands, has frequent dews, which creates ideal conditions for rust infection. In 1989, rust was the third most prevalent disease observed (Table 1). This seemingly rapid increase in rust prevalence is believed to be attributable to the shift in rust races (6), a change in the parental lines grown within the state, and atypical weather. Races 3 and 4 were the only races identified from 1988 and 1989 samples. Weather data collected by the California Irrigation Management System in the sunflower production area revealed that there were twice as many days on which dew occurred during the summer of 1989 compared with the two previous years. Whereas rust is on the quarantine disease list, only New Zealand specifically restricts seed importation because of rust.

The sclerotial fungi, *S. sclerotiorum*, *S. minor* Jagger, and *Sclerotium rolfsii* Sacc., have a wide distribution in California, causing losses on many crop species (2). Incidence in sunflower fields was usually never greater than 10% (Table 1). Wilted plants are commonly rogued, thus slowing disease spread. *S. rolfsii* was more commonly observed in fields rotated with sugar beets, whereas the two Sclerotinia diseases were more common in the cooler regions of the valley near the delta. It was not uncommon to find more than one sclerotial fungus in a field, which complicated disease recognition. Symptoms of *S. minor*, *S. sclerotiorum*, and *S. rolfsii* are almost indistinguishable, with differentiation based solely on sclerotial size and color and the presence of clamp connections with *S. rolfsii*. Sclerotinia head rot was found in three fields in 1989; once in a dwarf hybrid and twice in a very late planted hybrid that matured during early September rains. Of the three sclerotial diseases, only *S. sclerotiorum* appears on the list of quarantine diseases. *S. sclerotiorum* causes two epidemiologically distinct diseases of sunflower. The basal stalk rot/wilt, which is initiated by root contact with soilborne sclerotia, produces sclerotia only on the roots and in the lower stalk. Head rot, initiated by windborne ascospores, produces abundant sclerotia in the head which are often not totally separated from the seed during harvesting. Thus, only Sclerotinia head rot is of primary concern with regard to seed disease transmission.

Charcoal rot of sunflower, caused by *Macrophomina phaseolina* (Tassi) Goidanich, was frequently observed during 1983–1988 but was found in only 9% of surveyed fields in 1989. The low incidence in 1989 is believed to be attributable to a cooler than normal season and early fall rains, both factors that diminish stresses that foster charcoal rot. No obvious associations between the previous crop and incidence of charcoal rot were noted.

The only bacterial disease observed during 1983–1988 was stalk rot (caused by *Erwinia* spp.) on an occasional plant in breeding nurseries. Certain sunflower genotypes are very susceptible; one field in the 1989 survey had >50% plants affected with bacterial stalk rot (Table 1). Apical chlorosis caused by *P. s.* pv. *tagetis* (Hellmers) Young et al, which is known to be seedborne (8), has not been observed nor have other bacterial leaf spots, such as that caused by *P. s.* pv. *helianthi* or *P. cichorii*. *P. cichorii*, which has only been reported on sunflower from Brazil (15), is a common pathogen of lettuce in the southern coastal counties of California, but this isolate does not infect sunflower (4).

Downy mildew was found in one out of 268 fields examined by county agricultural inspectors for phytosanitary certification in 1989; it was not detected in any of the 87 fields surveyed by D. M. Woods. The isolate was identified as race 4 and affected 0.01% of the plants in that field. This marks only the second time in 11 yr that downy mildew has been observed on sunflower in California (17). Greenhouse growouts of 5,000 seedlings of the same seedlots planted in the field failed to reveal any plants with symptoms of downy mildew. Inspections of 16 other fields planted with the same seed lot also failed to detect any other plants infected with mildew. Because *P. halstedii* infects other Compositae genera besides *Helianthus* spp., many of which are

Table 1. Sunflower diseases in seed production fields in the Sacramento Valley of California during 1989

Disease Pathogen	DP[a] (%)	DI[b] (%)	Fields (%) with given DI				
			0%	<1%	2–10%	11–50%	>50%
Head rot *Rhizopus oryzae*	70.1	5.3	30	39	22	7	2
Powdery mildew *Erysiphe cichoracearum*	36.8	8.4	63	14	7	9	7
Rust *Puccinia helianthi*	31.0	2.3	69	21	6	3	1
Wilt/basal stalk rot *Sclerotinia sclerotiorum*	23.0	0.5	77	16	7	0	0
Wilt/basal stalk rot *Sclerotinia minor*	12.6	0.7	87	7	5	1	0
Charcoal rot *Macrophomina phaseolina*	9.2	0.5	91	6	2	1	0
Wilt/basal stalk rot *Sclerotium rolfsii*	6.9	0.2	93	5	2	0	0
Bacterial stalk rot *Erwinia* spp.	3.4	0.9	97	2	0	0	1
Head rot *Sclerotinia sclerotiorum*	3.4	0.1	97	1	2	0	0

[a]DP = Disease prevalence, defined as the percentage of 87 surveyed fields in which disease was found.

[b]DI = Disease incidence, defined as the percentage of plants affected by a disease, averaged over all 87 surveyed fields.

indigenous to California, zoosporangia may come from wild sunflowers or other susceptible Compositae plants (16). Because of the occurrence of multiple races of downy mildew in North America and their relative scarcity elsewhere, many counties restrict seed importation. The fact that only two documented cases of downy mildew on sunflower have occurred in California in the past 11 yr suggests that the climate in the Sacramento Valley is generally not conducive to mildew infection.

As part of the phytosanitary inspection process, 365 samples of suspected sunflower disease from 1,100 fields were submitted to the Analysis and Identification Laboratory between 1983 and 1988. The most frequent diagnoses were for phenoxy-type herbicide injury and chimeras, which mimic viral symptoms. Only 11 samples (3%) were confirmed to have pathogens, none of which were of quarantine significance. The pathogens identified were *S. rolfsii*, *Fusarium oxysporum* Schlectend.:Fr. (isolated from the crown of wilted plants), *Pythium* sp., and *Phyllactinia* sp. The latter is believed to be the first record of *Phyllactinia* sp. causing powdery mildew on sunflower (11). Thus, diseases of quarantine significance were extremely rare in seed fields under California conditions between 1983 and 1988.

Fungal diseases that have not been recorded on California sunflower during this period included Phomopsis stem canker, Phoma black stem, Verticillium wilt, Septoria leaf spot, Alternaria leaf spot (caused by *A. helianthi* (Hansf.) Tubaki & Nishihara and *A. zinniae* M. B. Ellis), and Phytophthora stem rot, of which the first four are considered quarantine diseases. No viral diseases were detected during this period, although aster yellows, beet western yellows virus, and lettuce infectious yellows virus have previously been confirmed on sunflower in California (2), although not from the Sacramento Valley. *O. cumana* has never been observed on any host in California. *O. ramosa* L. has not been observed on sunflower in California but has been identified in California on the following hosts: *Cannabis sativa* L., *Chrysanthemum* × *morifolium* Ramat., *Lactuca sativa* L., *Lycopersicon esculentum* Mill., *Polygonum persicaria* L., and *Xanthium spinosum* L. (2).

These observations parallel those made by Klisiewicz and Beard in their 1973–1975 study of California sunflower fields with some exceptions (9). Rhizopus head rot was the most prevalent disease in both surveys. Neither *S. minor* nor *S. rolfsii* were observed on sunflower in the previous survey. Verticillium wilt was detected in the earlier survey but only from the San Joaquin Valley; currently, there is no sunflower seed production in that area. The high temperatures and low relative humidities of the Sacramento Valley are not conducive to most foliar pathogens, with the exception of powdery mildew, which does not require free water for germination. Of the many fungal and bacterial foliar diseases of sunflower, only powdery mildew and rust were observed in both surveys.

The overall disease picture of California sunflower production is thus quite different from that of the north central states, where Phoma black stem, downy mildew, Sclerotinia wilt, and Alternaria leaf blight were found in 73, 59, 48, and 48%, respectively, of inspected fields (5). Phomopsis stem canker, the most important disease affecting sunflower in Europe, has been found throughout the midwestern U.S. sunflower production area (T. J. Gulya and S. Masirevic, *unpublished data*) but not from California. Despite the increased amount of sunflower production in the Sacramento Valley, this area still has relatively few sunflower disease problems that affect production or the issuance of phytosanitary certificates. Seed treatment with metalaxyl to prevent downy mildew, Pythium, and Phytophthora seedling rots (12), managing Rhizopus head rot through insect control, and following a 4- to 5-yr rotation to preclude a buildup of soilborne pathogens (11) are the major factors that will ensure that California sunflower seed production remains relatively problem-free.

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