Differences in Epidemiology and Control of Lettuce Drop Caused by *Sclerotinia minor* and *S. sclerotiorum*

C. L. PATTERSON and R. G. GROGAN, Department of Plant Pathology, University of California, Davis 95616

ABSTRACT

Patterson, C. L., and Grogan, R. G. 1985. Differences in epidemiology and control of lettuce drop caused by *Sclerotinia minor* and *S. sclerotiorum*. Plant Disease 69:766-770.

Sclerotial inoculum was decreased and lettuce drop was eliminated after three consecutive years of roguing lettuce plants infected by *Sclerotinia minor*. Significant reduction of drop caused by *S. minor* was achieved by one application of DCNA, iprodione, or vinclozolin immediately after thinning. Apothecia of *S. sclerotiorum* were found in the late fall, winter, and spring in the San Joaquin Valley during prolonged wet periods. Effective control of *S. sclerotiorum*, therefore, is influenced by the timing of fungicide applications and the source of apothecia and ascospore inoculum. Because of the endemic occurrence of *S. sclerotiorum* in the San Joaquin Valley, two fungicide applications may be required for efficient disease control.

Lettuce (*Lactuca sativa* L.) in California is grown in different localities depending on the season. The time and place of planting is selected to provide cool weather at or near harvest to avoid tip burn and bolting. In the Salinas Valley, two crops of lettuce have been grown in some fields for many years. *Sclerotinia minor* is the predominant species causing lettuce drop in that region. In the San Joaquin Valley, *S. sclerotiorum* is the primary cause of drop when lettuce culture is initiated. After repeated cropping of lettuce in the same fields, however, *S. minor* has increased in relative incidence. In both districts, the occurrence of lettuce drop caused by *S. sclerotiorum* is sporadic. It usually occurs in spring-maturing crops exposed to prolonged rainy and foggy overcast weather that keeps the soil near saturation and allows for the formation of apothecia (7). In contrast, infection of lettuce by *S. minor* occurs in infested fields during all seasons, even when the incidence of drop caused by *S. sclerotiorum* is nil. When the two species occur together, *S. sclerotiorum* often surpasses *S. minor* in incidence. Beach (5) also noted that occurrence of lettuce drop caused by *S. minor* was more consistent, whereas that caused by *S. sclerotiorum* was sporadic and occurred only after prolonged wet periods.

S. minor (referred to as *S. sclerotiorum* '*minor*' by Adams and Tate [3,4]) infects lettuce roots and crowns directly by eruptively germinating sclerotia (4) (Fig. 1), and a single sclerotium can infect and kill a lettuce plant (10). Sclerotia further than 2 cm from the root usually cannot infect and those deeper than 8 cm do not germinate (10). Therefore, the competence volume of soil containing sclerotia of *S. minor* near enough to the lettuce root to have a potential for infection is about 100-cm^3 (6). Both *S. minor* and *S. sclerotiorum* can infect by hyphal germination of sclerotia that are contacted by senescing lower leaves on the soil surface. However, the relative importance of this mode of infection has not been determined. In other crops, *S. sclerotiorum* infects senescing plant tissues by ascospores (1,2,8,9,13–15), and with the exception of sunflower (9), direct infection by sclerotia is not considered important.

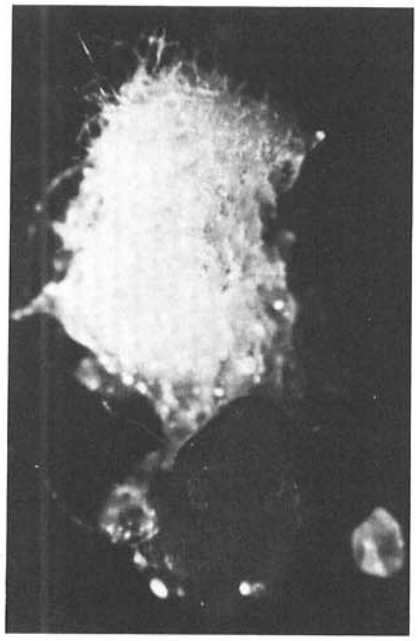

Fig. 1. Eruptive myceliogenic germination by a sclerotium of *Sclerotinia minor*.

The number of soilborne sclerotia of *S. minor* is highly correlated with disease incidence (3,6,10), but the incidence of lettuce drop caused by *S. sclerotiorum* is not. The presence of sclerotia of *S. minor* in a field ensures the occurrence of some drop. However, the occurrence of lettuce drop caused by *S. sclerotiorum* is not consistently correlated with the presence, or relative number, of sclerotia in a field. In fact, we have observed losses as high as 70% from lettuce drop caused by *S. sclerotiorum* in fields where sclerotia were not detected by soil sampling.

Smith (14) reported that *S. sclerotiorum* grew from plant material collected in California during prolonged wet periods after incubation in a moist chamber. He concluded that ascospores were commonly airborne and that they contaminated plant material during cool rainy periods in the winter and spring. Thus, ascospores from other sources probably account for the high incidence of lettuce drop in fields where sclerotia were not detected.

Beach (5) demonstrated that roguing lettuce plants infected by *S. minor* and drenching the rogued area with Bordeaux mixture reduced drop by 50% in the following crop. This procedure probably would be less effective against *S. sclerotiorum* because fields may become contaminated by airborne ascospores that infect plants and replenish soilborne sclerotial inoculum. The apothecial stage of *S. minor* rarely if ever occurs naturally in California (12). Therefore, removal of infected lettuce residue should result in a decrease of soilborne sclerotia and eventual elimination of the disease.

Fungicides have been used extensively for control of lettuce drop in California. When applied properly, they significantly reduce the incidence of disease (11,12). Most of the research with fungicides, however, has been conducted to control *S. minor*. Very little work has been done to compare materials and application timing for control of both species.

In this paper, we confirm that the epidemiology of lettuce drop caused by *S. minor* and *S. sclerotiorum* is distinctly different. Evidence is presented showing that reduction of soilborne sclerotia of *S. minor* by continuous roguing of infected lettuce plants is a feasible procedure for eliminating drop. We also report results from fungicide experiments demonstrating that *S. minor* and *S. sclerotiorum* require

This research was supported in part by the California Iceberg Lettuce Research Advisory Board.

Accepted for publication 9 April 1985 (submitted for electronic processing).

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

different fungicide application schedules for effective disease control.

MATERIALS AND METHODS

Roguing and fungicide experiments were conducted in commercial lettuce fields. Iceberg lettuce was planted on raised 100-cm-wide, double-row beds with a 30-cm spacing between rows. Plants with four to six true leaves were thinned to a 30-cm spacing. The cultivars planted were Salinas in the Salinas Valley and Empire in the San Joaquin Valley.

Roguing lettuce plants infected by *S. minor*. Lettuce plants infected by *S. minor* were removed from 3 ha of an 8-ha field near Soledad, CA, during a 3-yr period (1980–1982). Infected plants, with crown and about 10 cm of root, were removed with a hand trowel every 2 wk beginning at thinning and continuing to harvest. Infected plants were collected in burlap bags, removed from the field, and discarded in a nearby ravine. Fifty soil samples were randomly collected from rogued and nonrogued areas of the field at planting or during the next fallow period. A hollow probe 4 cm in diameter, inserted 8 cm deep, was used to collect the samples (about 100-cm^3). The samples collected in 1980 and 1981 were bulked, but in 1982, each sample was processed separately. Sclerotia were extracted from the entire bulked sample in 100-cm^3 portions and from each of the individual 1982 samples by a wet-sieve method (3). Data were recorded as the average number of sclerotia per 100-cm^3 volume of soil, i.e., 50 samples each from rogued and nonrogued areas. The number of *S. minor*-infected plants was recorded during each removal procedure, and at harvest, the total number of infected plants was recorded as the percentage of plants infected by *S. minor* in the rogued and nonrogued plots.

Fungicide applications for control of *S. minor* on lettuce. DCNA, iprodione, and vinclozolin were applied at different rates and times for control of lettuce drop caused by *S. minor*. DCNA treatments were 2.50 and 4.20 kg/ha; the other fungicides were applied at 0.28, 0.56, and 1.12 kg/ha. The application schedules were A) immediately after planting, B) after planting and after thinning (fourth- to sixth-true-leaf stage, 30 days after planting), and C) after thinning. The materials were applied as wettable powders in 700 L of H_2O/ha at 2.8 kg/cm^2 pressure with a backpack CO_2 sprayer. An 8002 tee-jet nozzle was used to distribute the materials in a band of 10–15 cm over the seed line.

Six experiments were conducted during a 3-yr period in the Salinas Valley. Treatments were arranged in a randomized complete block design (RCBD) replicated four times. Each treatment replicate was 1 m (one planting bed) × 15 m. Disease incidence was determined in the plots by examination of wilted plants 3 days before harvest. Data were analyzed by a four-way factorial analysis of variance (AOV). Factors included fungicide tested, rate of fungicide, timing of application, and location of experiment. Levels of significance were determined by Fisher's protected LSD (PLSD). Results are reported as the average percentage of lettuce plants infected by *S. minor* in six experiments replicated four times.

Fungicide applications for control of *S. sclerotiorum*. Four fungicide experiments for control of lettuce drop caused by *S. sclerotiorum* were conducted during the winter and spring of 1983 and 1984 in the San Joaquin Valley. In three experiments conducted in 1983, the fungicides were applied immediately after thinning (fourth- to sixth-true-leaf stage, about 40 days after planting) or during the rosette stage of growth (about 35 days before harvest). The objective of the rosette-stage application was to protect senescing lower leaves from infection by ascospores. Materials and rates were DCNA at 2.50 and 4.20 kg/ha; vinclozolin at 0.28, 0.56, and 1.12 kg/ha; and a combination of DCNA and vinclozolin at 2.50 plus 0.28 kg/ha and 2.50 plus 0.56 kg/ha, respectively. The volume of the fungicide mix was as previously described. A spreader/sticker (77% modified phthallic glycerol alkyd resin) was added to the tank mix (2 ml/L of H_2O) applied during the rosette stage.

The fungicide experiment conducted in 1984 included DCNA and vinclozolin as described and iprodione at rates equivalent to those of vinclozolin. The combination of DCNA and vinclozolin was not included. Fungicides were applied at thinning time (fourth- to sixth-true-leaf stage, about 40 days after planting), the rosette stage (about 35 days before harvest), and at both thinning and the rosette stage. Modified phthallic glycerol alkyd resin was added to the tank mix (2 ml/L of H_2O) applied during the rosette stage.

Fungicide applications made during the rosette stage differed from those at thinning time in that foliage was sprayed instead of a band over the soil surface in the seed row. Fungicide treatments were arranged in a RCBD and replicated four times. The experimental plots in 1983 were 2 m (two planting beds) × 15 m and those in 1984 were 1 × 15 m. Three days before harvest, the fungicides were evaluated for efficacy by determining the percentage of plants with drop symptoms in each individual plot. Data collected in 1983 were analyzed by a four-way factorial AOV. Factors included fungicide tested, rate of fungicide, timing of application, and experiment location. Data collected in 1984 were analyzed by a three way factorial AOV. Factors included fungicide tested, rate of application, and timing of application. Levels of significance were determined by a PLSD test. Data are expressed as the average percentage of drop in four replicates.

Comparative control of *S. minor* and *S. sclerotiorum*. In one field in the San Joaquin Valley, both *S. minor* and *S. sclerotiorum* occurred during the winter of 1982. DCNA was applied (4.2 and 8.4 kg/ha) at thinning (fourth- to sixth-true-leaf stage, 40 days after planting), the rosette stage (35 days before harvest), or at both times. Modified phthallic glycerol alkyd resin (77%) was added to the tank mix (2 ml/L of H_2O) for applications made during the rosette stage. A commercial applicator applied the material in 935 L of H_2O/ha at 7 kg/cm^2 pressure (CO_2 pressure source). The thinning-time application was applied as a 10-cm band over the seed line, whereas the rosette-stage application covered the entire plant.

Each treatment plot was 16 m (16 planting beds) × 372 m in an RCBD replicated four times. At harvest, the percentages of plants with obvious drop symptoms caused by *S. minor* or *S. sclerotiorum* were recorded as determined by examination of infected tissue for relative sclerotial size. Data were analyzed by a three-way factorial AOV. Factors were the time of application, amount of fungicide applied, and species controlled. Levels of significance were determined by a PLSD test. Data are expressed as the average percentage of lettuce drop caused by *S. minor* or *S. sclerotiorum* in four replicates.

Effect of DCNA, iprodione, and vinclozolin on apothecial formation by sclerotia of *S. sclerotiorum*. Sclerotia of *S. sclerotiorum* were buried 1 cm deep in field soil (Yolo fine sandy loam) in 15-cm-diameter pots (10 sclerotia per pot). After wetting, the soil surface was treated with the test fungicides by a Hudson sprayer. Materials and rates were in kilograms-per-hectare equivalents of DCNA, iprodione, and vinclozolin at the same rates as used in the field experiments. Each treatment was applied to five separate pots (10 ml of solution per pot, 50 sclerotia total). The pots were placed in an environmentally controlled chamber at 15 C and misted for 20 sec every 4 hr. The source of light was from the sun filtered through greenhouse glass and the polyvinyl chloride cover of the mist chamber.

Sclerotia in pots treated with the fungicides were observed for apothecial production weekly for 70 days and compared with an untreated control. Data were analyzed by an orthogonal comparison and linear trend analysis and recorded as the percentage of sclerotia producing apothecia in 7-day intervals.

RESULTS

Roguing. Incidence of *S. minor* in the lettuce field when roguing of infected plants was begun was about 17%. In the first crop grown after roguing, sclerotial populations were reduced 10-fold and disease incidence was decreased by 50% compared with the nonrogued area

(Table 1). Inoculum levels progressively decreased after removal of infected plants from each successive lettuce crop. During April and July 1982, no sclerotia were detected in soil samples from the rogued area and the incidence of disease was nil. Planting of lettuce without roguing resulted in an increase in sclerotia after each crop and a consistently higher level of disease incidence. Periods of winter fallow and rotation with broccoli decreased sclerotial numbers and disease incidence in both rogued and nonrogued areas.

Fungicidal control of *S. minor*. The most effective fungicidal control of *S. minor* resulted when applications were made immediately after thinning (Table 2). An additional application at planting did not improve disease control, and no appreciable control resulted when the fungicides were applied at planting only. In application schedules B and C, the fungicides usually were most effective when applied at the highest concentration ($P = 0.05$).

Fungicidal control of *S. sclerotiorum*. In 1983, the fungicide treatments applied during the rosette stage resulted in good control of lettuce drop caused by *S. sclerotiorum* (Table 3) but did not differ significantly from each other ($P = 0.05$). No control of *S. sclerotiorum* was achieved from materials applied immediately after thinning. In 1984, treatments applied at the thinning stage resulted in good disease control, whereas those applied during the rosette stage did not control lettuce drop (Table 4). In addition, a fungicide application at both thinning and the rosette stage did not always significantly increase disease control. The fungicides differed in efficacy, and some treatments were better than others. DCNA at 2.50 and 4.20 kg/ha and iprodione and vinclozolin at 0.56 and 1.12 kg/ha were superior to the other applications and did not differ significantly from each other ($P = 0.05$).

Comparative control of *S. minor* and *S. sclerotiorum*. DCNA applied at thinning reduced lettuce drop caused by *S. minor* but not that caused by *S. sclerotiorum* (Table 5). Fungicide applications during the rosette stage controlled *S. sclerotiorum* but not *S. minor*. When DCNA was applied at thinning and the rosette stage, both species were controlled. The two rates of DCNA resulted in similar control of lettuce drop caused by both species and significantly decreased the incidence of disease ($P = 0.05$).

Effect of fungicides on apothecial formation by sclerotia of *S. sclerotiorum*. An orthogonal comparison and trend analysis indicated a linear relationship between fungicide rates and inhibition of apothecial production by sclerotia of *S. sclerotiorum* ($r^2 = 0.90$) (Table 6).

DCNA at 4.20 kg/ha and iprodione and vinclozolin at 1.12 kg/ha resulted in the most effective long-term inhibition of carpogenic germination by sclerotia of *S. sclerotiorum* ($P = 0.05$) (Table 6). In the fungicide treatments, apothecia were not produced until 63 days after application, whereas in the untreated control, apothecia were produced within 21 days. The final percentages of germination in the fungicide treatments were 2, 4, and 4, respectively, compared with 90% in the control. Apothecia were produced by sclerotia within 42 days when DCNA was applied at 2.50 kg/ha and iprodione and vinclozolin were applied at 0.56 kg/ha. DCNA had the most residual effect ($P = 0.05$); however, the final percentages of germination by sclerotia in the three treatments were 14, 52, and 48, respectively. Iprodione and vinclozolin at 0.28 kg/ha did not result in long-term inhibition of apothecial production by sclerotia of *S. sclerotium* and also did not significantly reduce the final percentage of germination ($P = 0.05$).

Table 1. Effect of roguing lettuce plants infected by *Sclerotinia minor* on subsequent sclerotical populations and disease incidence[a]

Sampling date[b]	Sclerotial population[c]		Harvest date	Disease incidence (%)	
	Removed	Not removed		Removed	Not removed
30 Jun. 1980	0.20	3.00	17 Aug. 1980	9.00	20.3
4 Sept. 1980	0.09	3.60	wf[d]	wf	wf
26 Feb. 1981	0.05	0.29	15 May 1981	3.10	12.3
4 Jun. 1981	0.02	2.30	br[d]	br	br
30 Apr. 1982	ND	0.17	17 Jul. 1982	0.06	4.7
24 Jul. 1982	ND	1.61	24 Sept. 1982	<0.01	12.1

[a] Average amount of drop present in plot area when roguing was begun was 17%. Recording of data was begun with the first crop after the initial roguing. Lettuce plants infected by *S. minor* and showing drop symptoms were removed every 2 wk.
[b] Sampling date corresponds with planting date of each crop or date of sampling during winter fallow.
[c] Recorded as mean number of sclerotia in 50 100-cm^3 samples. ND = none detected.
[d] wf = Winter fallow; br = broccoli.

Table 2. Reduction of lettuce drop caused by *Sclerotinia minor* by DCNA, iprodione, and vinclozolin[a]

Treatment	Rate (kg/ha)	Disease incidence (%)[b,c]		
		A	B	C
DCNA	2.50	22	16	15
	4.20	19	11	13
Irpodione	0.28	23	17	12
	0.56	23	11	14
	1.12	18	7	11
Vinclozolin	0.28	21	17	10
	0.56	18	12	10
	1.12	13	7	5
Control	0.00	28	32	29

[a] Summary of six field experiments conducted in the Salinas Valley, CA, during 1981–1983.
[b] Application schedule: A = immediately after planting, B = after planting and after thinning (about 30 days after planting), and C = after thinning.
[c] Results are expressed as an average of four replicates. Data were analyzed by a four-way analysis of variance. PLSD 0.05 = 5.23.

Table 3. Reduction of lettuce drop caused by *Sclerotinia sclerotiorum* by DCNA, vinclozolin, and combinations of DCNA and vinclozolina[a]

Treatment	Rate (kg/ha)	Disease incidence (%)[b,c]	
		A	B
DCNA	2.50	26.72	12.16
	4.20	27.00	10.52
Vinclozolin	0.28	26.72	12.16
	0.56	27.80	9.25
	1.12	29.43	14.00
DCNA + vinclozolin	2.50 + 0.28	28.35	12.91
	2.50 + 0.56	31.26	8.58
Control	0.00	29.81	27.50

[a] Summary of three field experiments conducted in the San Joaquin Valley, CA, during 1983.
[b] Application schedule: A = immediately after thinning (about 40 days after planting) and B = at the rosette stage of growth (about 35 days before harvest).
[c] Results are expressed as an average of four replicates. Data were analyzed by a four-way analysis of variance. PLSD 0.05 = 8.34.

DISCUSSION

Results of this investigation confirm that *S. minor* and *S. sclerotiorum* differ epidemiologically and demonstrate that

effective control procedures also must be different. *S. minor* was eliminated after 3 yr of roguing infected lettuce plants. Thus, spread by ascospores that infect plants and replenish soilborne sclerotial inoculum is not important in California. Roguing should begin with the first indication of drop (usually shortly after thinning). Otherwise, plants infected early may disintegrate and could be missed if roguing were done only once just before harvest. The estimated cost of roguing the field was about $500/ha for the 3-yr period. This control procedure is economically feasible and efficient because it can eliminate the need for fungicides. After the percentage of drop is reduced by roguing, the costs for roguing in subsequent years are low or nil. The cost of a fungicide application is about $60; however, the cost recurs with each lettuce crop.

Although roguing was not tested for control of *S. sclerotorium*, it probably would not be as effective as for *S. minor*. Ascospores were commonly present in lettuce fields during late fall, winter, and spring and were trapped on acidified potato-dextrose agar, even in fields where we were unable to find apothecia (C. L. Patterson and R. G. Grogan, *unpublished*). Furthermore, on numerous occasions, lettuce leaves collected from apparently healthy plants were shown by examination of mycelial growth and formation of sclerotia after incubation in a moist chamber to be infested with ascospores of *S. sclerotriorum* (C. L. Patterson and R. G. Grogan, *unpublished*). In some fields, we observed gradients of disease incidence with less disease further from the field edge and source of inoculum as indicated by presence of apothecia. Thus, removing *S. sclerotiorum*-infected lettuce plants to reduce in-field inoculum probably would not result in long-term disease control.

Fungicide applications on lettuce clearly demonstrated that effective control procedures for *S. minor* and *S. sclerotiorum* must be different (Tables 2–5). *S. minor* infects lettuce roots and crowns directly from eruptively germinating soilborne sclerotia. Fungicides must be applied to place the material around the crown and upper root areas and to form a protective layer between the soil surface and lower leaves. Therefore, fungicides should be applied immediately after thinning and cultivation when plants are small. Afterward, the soil surface, with a fungicide film, should not be disturbed.

Results from applying fungicides for control of *S. sclerotiorum* are variable (Tables 3–5). The effectiveness of applications apparently is influenced by the source of ascospore inoculum. In the 1982 and 1983 experiments (Tables 3 and 5), apothecia were never observed in the test fields. They were found, however, in adjacent fields and orchards. Thus, most ascospore inoculum likely was from these sources and fungicide applications during the rosette stage of growth were adequate for protecting exposed foliage. In contrast, in the 1984 experiment (Table 4), sclerotia were present in the lettuce field and apothecia were observed throughout the cropping period but were not observed in adjacent fields. Therefore, outside sources of ascospore inoculum were nearly nil, whereas in-field inoculum was much more prevalent than in the 1982 and 1983 trials. In this situation, fungicide applied at thinning resulted in significant disease control. On the basis of results from greenhouse fungicide experiments (Table 6), this was probably due to fungicidal inhibition of apothecial production by sclerotia. Foliar appli-

Table 4. Effects of application timing and rate of DCNA, iprodione, and vinclozolin on lettuce drop caused by *Sclerotinia sclerotiorum*[a]

Treatment	Rate (kg/ha)	Disease incidence (%)[b,c]		
		A	B	C
DCNA	2.50	8.0	7.0	19.0
	4.20	7.0	4.0	22.0
Iprodione	0.28	29.0	10.0	29.0
	0.56	10.0	6.0	20.0
	1.12	10.0	3.0	16.0
Vinclozolin	0.28	12.0	6.0	13.0
	0.56	8.0	3.0	24.0
	1.12	2.0	2.0	14.0
Control	0.00	22.0	29.0	19.0

[a] Summary of results of one field experiment conducted in the San Joaquin Valley, CA, during 1984.
[b] Application schedule: A = at thinning (about 40 days after planting), B = at both thinning and the rosette stage of growth, and C = at the rosette stage (about 35 days before harvest).
[c] Results are expressed as an average of four replicates. Data were analyzed by a three-way analysis of variance. PLSD 0.05 = 6.71.

Table 5. Comparative control by DCNA of lettuce drop caused by *Sclerotinia minor* or *S. sclerotiorum*

Treatment	Rate (kg/ha)[a]		Disease incidence (%)[b]	
	After thinning	Rosette stage	*S. minor*	*S. sclerotiorum*
DCNA	4.2	0.0	6.2	14.3
	8.4	0.0	5.9	15.3
	0.0	4.2	11.2	6.3
	0.0	8.4	10.8	5.7
	4.2	4.2	5.8	6.0
	8.4	8.4	5.7	6.2
	4.2	8.4	6.1	5.8
	8.4	4.2	6.3	6.4
Control	0.0	0.0	12.4	15.2

[a] Applications were made in a field plot where both *S. minor* and *S. scleroriorum* occurred: after thinning (about 40 days after planting) and at the rosette stage of growth (about 35 days before harvest).
[b] Data were analyzed by a three-way analysis of variance. PLSD 0.05 = 4.67.

Table 6. Effects of DCNA, iprodione, and vinclozolin on carpogenic germination by sclerotia of *Sclerotinia sclerotiorum*[a]

Treatment[b]	Rate[c] (kg/ha)	Sclerotia with apothecia (%)[d] (days of incubation)								
		14	21	28	35	42	49	56	63	70
Control	0.00	0	4	10	36	50	64	84	90	90
DCNA	2.50	0	0	0	0	4	6	8	14	14
	4.20	0	0	0	0	0	0	0	2	2
Iprodione	0.28	0	2	8	36	48	60	80	90	92
	0.56	0	0	0	0	8	20	26	40	52
	1.12	0	0	0	0	0	0	0	2	4
Vinclozolin	0.28	0	2	10	32	50	66	78	84	88
	0.56	0	0	0	0	10	18	22	34	48
	1.12	0	0	0	0	0	0	0	4	4

[a] Summary of three experiments.
[b] Sclerotia were buried 1 cm deep in 15-cm pots containing field soil. The soil surface was treated with the appropriate fungicide by a Hudson sprayer (10 ml of solution per pot).
[c] Determined by the area of a 15-cm-diameter planting surface.
[d] Observations for germination of sclerotia were made every 7 days for 10 wk. Data are presented as the percentage of germinating sclerotia at any observation time (10 sclerotia per 15-cm pot, five pots per treatment). An orthogonal comparison and trend analysis indicate a linear relationship between fungicide rate and duration of inhibition of sclerotial germination ($r^2 = 0.90$).

cations of fungicides only during the rosette stage did not result in significant disease control, probably because of high inoculum levels and inadequate coverage of lower leaves that were exposed to heavy showers of ascospores. Thus, when *S. sclerotiorum* is predominant and apothecia are being produced within the field, two fungicide applications may be required for effective control of lettuce drop.

LITERATURE CITED

1. Abawi, G. S., and Grogan, R. G. 1975. Source of primary inoculum and effects of temperature and moisture on infection of beans by *Whetzelinia sclerotiorum*. Phytopathology 65:300-309.
2. Abawi, G. S., and Grogan, R. G. 1979. Epidemiology of diseases caused by *Sclerotinia* species. Phytopathology 69:899-903.
3. Adams, P. B., and Tate, C. J. 1975. Factors affecting lettuce drop caused by *Sclerotinia sclerotiorum*. Plant Dis. Rep. 59:140-143.
4. Adams, P. B., and Tate, C. J. 1976. Mycelial germination of sclerotia of *Sclerotinia sclerotiorum* on soil. Plant Dis. Rep. 60:515-518.
5. Beach, W. S. 1921. The lettuce 'drop' due to *Sclerotinia minor*. Pa. Agric. Exp. Stn. Bull. 165:16-23.
6. Dillard, H. R., and Grogan, R. G. 1985. Relationship between sclerotial spatial pattern and density of *Sclerotinia minor* and the incidence of lettuce drop. Phytopathology 75:90-94.
7. Duniway, J. M., Abawi, G. S., and Steadman, J. R. 1977. Influence of soil moisture on the production of apothecia by *Whetzelinia sclerotiorum*. Proc. Am. Phytopathol. Soc. 4:115.
8. Grogan, R. G., and Abawi, G. S. 1975. Influence of water potential on growth and survival of *Whetzelinia sclerotiorum*. Phytopathology 65:122-128.
9. Huang, H. C., and Hoes, J. A. 1980. Importance of plant spacing and sclerotial position to development of Sclerotinia wilt of sunflower. Plant Dis. 64:81-84.
10. Imolehin, E. D., and Grogan, R. G. 1980. Factors affecting survival of sclerotia, and effects of inoculum density, relative position, and distance of sclerotia from the host on infection of lettuce by *Sclerotinia minor*. Phytopathology 70:1162-1167.
11. Marcum, D. B., Grogan, R. G., and Greathead, A. S. 1977. Fungicide control of lettuce drop caused by *Sclerotinia sclerotiorum 'minor'*. Plant Dis. Rep. 61:555-559.
12. Patterson, C. L., and Grogan, R. G. 1984. Comparative epidemiology and control of lettuce drop caused by *Sclerotinia minor* and *S. sclerotiorum*. (Abstr.) Phytopathology 74:839.
13. Smith, R. E. 1900. *Botrytis* and *Sclerotinia*: Their relationship to certain plant diseases and each other. Bot. Gaz. 29:369-407.
14. Smith, R. E. 1931. The life history of *Sclerotinia sclerotiorum* with reference to the green rot of apricot. Phytopathology 21:407-423.
15. Stone, G. E., and Smith, R. E. 1900. The rotting of greenhouse lettuce. Mass. Agric. Exp. Stn. Bull. 69. 40 pp.