Burning to Reduce Sclerotia of *Sclerotinia sclerotiorum* in Alfalfa Seed Fields of Southeastern Washington

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ABSTRACT

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Fall burning produced an intense surface fire that reduced numbers of sclerotia in an alfalfa seed field by >95%. The fire killed sclerotia in the dense layer of surface plant residue and scorched and killed sclerotia in the surface soil (0–2 cm). Only 14% of the collected surface soil sclerotia were viable after the fall burn. During the next 6 mo, the detectable number of sclerotia in surface soil samples declined from $246/m^2$ in November to $7/m^2$ in May and viability of sclerotia declined from 12 to 0%, respectively. Winter burning reduced surface residue and numbers of sclerotia but had no detectable effect in reducing the viability and survival of surface soil sclerotia. Spring mowing of the plant canopy did not reduce numbers of sclerotia nor influence the survival and viability of sclerotia. Alfalfa seed yields were 43 and 13% greater following fall burn and spring mowing treatments, respectively, than following the standard practice of winter burning.

Additional keywords: *Medicago sativa*

Sclerotinia crown and stem rot of alfalfa (*Medicago sativa* L.) is known to occur in cool, humid areas of Europe and North America (1,4,7). The disease, caused by *Sclerotinia sclerotiorum* (Lib.) deBary, has also been reported (3) in the dry and hot desert climate of southeastern Washington, where it has caused severe damage in broadcast-planted alfalfa seed production fields of the Touchet-Gardenia area near Walla Walla (3). The steep-sloped topography and easily erodible surface soils have prevented the use of row-planted alfalfa seed fields in the area. Therefore, to prevent excessive erosion, alfalfa seed fields are broadcast-planted.

Cool temperatures, high humidities, a wet soil surface, and the dense canopy of the broadcast-planted seed fields favor disease development (6,7). These environmental conditions occur frequently in the area, especially in the months of April, May, and June (3). During June and July, many fields throughout the area have shown considerable browning and dieback caused by *S. sclerotiorum*. There are no cultivars of alfalfa resistant to Sclerotinia crown and stem rot, and the only control measures are cultural practices (7). Therefore, the major objective of this study was to evaluate cultural control practices (such as fall burning and spring mowing) that would suppress or prevent severe Sclerotinia crown and stem rot disease in broadcast-planted alfalfa seed fields in which winter burning was a standard production practice for removal of overwintered plant residue.

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MATERIALS AND METHODS

Description of experimental alfalfa seed field. The field selected was a 4-yr-old stand of G777 (Funks) alfalfa that was severely infected with *Sclerotinia*. The field size was 24 ha with a length orientation from north to south. Plots of approximately 4 ha were marked out starting with the north end of the field. Treatments consisted of 1) fall burn of harvested dry residue in November or as soon after seed harvest as possible, 2) winter burn of surface residue in February, and 3) winter burn plus spring mowing of the plant canopy in early May. Control plots consisted of the winter-burn procedure and were alternated between each treatment. During the growing season, established farm management practices for alfalfa seed production were applied to the field including overhead irrigation in the spring (April–May) and fall (October–November), and fertilizer, herbicide, and pesticide applications, as required.

Fall burning. Only one plot at the north end of the field was given the fall burn after seed harvest. Fire control lines were established with overhead irrigation sprinklers along the sides of the plot to prevent spread of the fire to the entire experimental field. When suitable wind direction and speed prevailed, the residue was set on fire with a propane torch drawn behind a tractor across the west end of the field. The dry residue layer produced a surface fire that burned completely and resulted in a field plot with a bare soil surface.

Winter burning. Winter burning has been a long-term, routine cultural farming practice in the alfalfa seed-producing area that also removed surface residue left from the fall seed harvest. This was done usually in February when the temperature and humidity were low, snow cover had melted, surface residue was dry, alfalfa crowns were dormant, and the winds were favorable for a rapid, controlled surface residue burn. Unburned and smoldering wet residue patches were dispersed and removed or incorporated into the soil surface by harrowing and lightly disking the field.

Spring mowing. The alfalfa crowns usually break winter dormancy in early March and, from mid-April to mid-May, the spring shoot growth produces a significant plant canopy. Mowing was done on duplicate plots with a rotary mower to simultaneously mow, chop, and disperse spring growth evenly over the surface of the plot area where it quickly dried.

Seed harvesting. In August, before harvesting in September or October, the plant canopy was desiccated with a Di-Nitro:kerosene mixture. A combine, with a cutting width of 5.4 m, was used to harvest the alfalfa seed. Seed yields were obtained from duplicate harvested areas within each plot (5.4 × 360 m) of approximately 0.2 ha.

Assay for sclerotia. Before harvest and before any treatments were applied, duplicate 1-m^2 samples of canopy, residue, and soil surface were collected from each plot as previously described (3). Also, after fall burning treatments and periodically throughout the next year's growing season, duplicate surface soil samples (1 m^2) were collected from each plot. Assays for sclerotia were as previously described (3). Viability of sclerotia was assayed on acidified potato-dextrose agar (PDA) incubated at 25 C.

RESULTS AND DISCUSSION

Effects of fall burning and winter burning on survival and viability of sclerotia. Assays of canopy-soil surface samples for sclerotia in September, just before seed harvest, determined that the density of *S. sclerotiorum* was 1,441 sclerotia/m^2 with 333, 763, and 345 sclerotia in alfalfa stem, surface residue, and surface soil samples, respectively.

The immediate effect of fall burning was the destruction of the dense layer of surface residue and associated sclerotia. Significantly fewer sclerotia (246/m^2) were collected from the surface soil after fall burning. Many were visibly discolored and scorched (Fig. 1) and only 12% grew on acidified PDA. Thus, fall burning destroyed 95% of the sclerotial inoculum in the field and severely influenced the survival and viability of the remaining 5%. Viability of sclerotia collected from non-fall burn plots was 92–97%. It should be noted further that the alfalfa crowns were not killed by the fall burn, but the spring regrowth was dense and healthy.

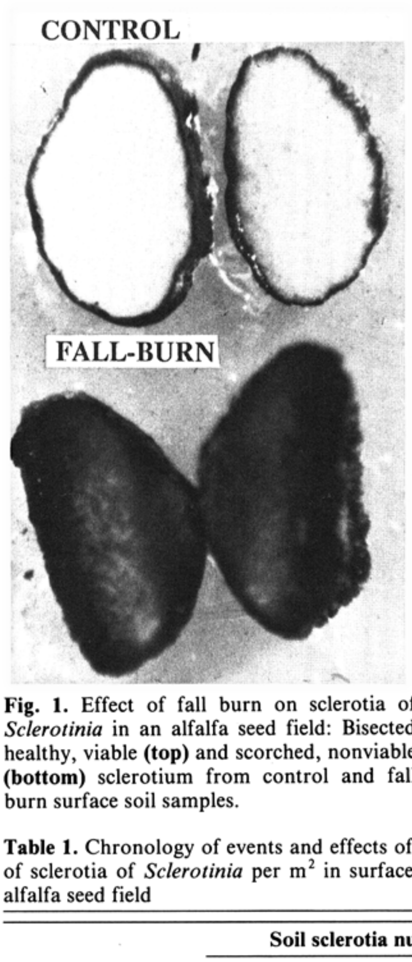

Fig. 1. Effect of fall burn on sclerotia of *Sclerotinia* in an alfalfa seed field: Bisected healthy, viable **(top)** and scorched, nonviable **(bottom)** sclerotium from control and fall burn surface soil samples.

Assays for sclerotia of surface soil samples, collected periodically throughout the growing season until seed harvest, indicated (Table 1) that the winter burning, which removed most of the overwintering surface residue, was not detrimental to the survival or viability of the remaining surface soil sclerotia. The winter burn produced a rapid surface fire that quickly burned the overwintered dry plant residue. None of the sclerotia collected from the surface soil were discolored, charred, or scorched, in contrast to the fall burn. However, assays of surface soil from the fall burn plot indicated inoculum had decreased from 246 following fall burning to 49 sclerotia/m^2 following the overwintering period. Subsequent samples in April and May showed further reductions in inoculum in the surface soil. A total of 72 sclerotia/m^2 were collected in March, April, and May with an average viability of 26%, compared to the control (winter burn) plots which had 946 sclerotia/m^2 with an average viability of 81%. A possible explanation for this is that the soil surface sclerotia surviving fall burning are weakened and thus more sensitive to winter conditions. They also may be more easily colonized by mycoparasites (2), such as *Sporidesmium sclerotivorum* Uecker, Ayers, & Adams, which are known to be in surface soil samples from the experimental field (P. B. Adams, *personal communication*). The sclerotia that produced apothecia during the spring months (April–May) in the fall burn plot were found at least 5 cm below the soil surface (R. G. Gilbert, *unpublished data*). Most of the apothecia detected in the fall burn plot were in close proximity to alfalfa crowns, where the sclerotia may have been more protected during the fall burn.

Table 1. Chronology of events and effects of cultural control practices on number and viability of sclerotia of *Sclerotinia* per m^2 in surface soil samples (0–2) cm) from a broadcast-planted alfalfa seed field

	Soil sclerotia numbers/m^2[a]			Sclerotia viability (%)[b]		
Date	Winter burn	Fall burn	Spring mow	Winter burn	Fall burn	Spring mow
18 October 1982	345	ND[c]	ND	96	ND	ND
20 October 1982			Seed harvest			
11 November 1982			Fall burning			
19 November 1982	313	246	ND	93	12	ND
24 February 1983			Winter burning			
17 March 1983	396	49	ND	90	20	ND
26 April 1983	256	16	ND	70	60	ND
02 May 1983			Spring mowing			
23 May 1983	294	7	332	80	0	60
05 July 1983	127	90	131	80	100	90
10 August 1983	129	125	109	70	80	90
15 September 1983	140	103	250	80	80	80
07 October 1983			Seed harvest			

[a] Duplicate (l-m^2) soil surface (0–2 cm) samples for sclerotial assays were collected periodically in 1983 from the time of approximate treatment to seed harvest.
[b] Viability of sclerotia was assayed on acidified PDA incubated at 25 C.
[c] ND = No data were collected until after fall burning and spring mowing treatments.

Increased numbers of sclerotia in surface soil samples collected from July to seed harvest in October reflected the formation of new, viable sclerotia resulting from infections that occurred in all plots (Table 1). As previously reported (3), *Sclerotinia*, though present in all alfalfa seed fields examined, was observed to be more severe in fields with plant residue remaining on the soil surface from the last harvest. The residue contained numerous sclerotia and possibly could serve as substrate for enhancement of mycelial infection from germinating ascospores or sclerotia. It has been reported that annual removal of diseased plant residue from the field will reduce *Sclerotinia* diseases on other crops (5). Therefore, harvest residue in alfalfa seed fields with a chronic or severe Sclerotinia crown and stem rot disease problem should be completely removed with fall burning.

Effect of spring mowing on *Sclerotinia* ecology. As expected, spring mowing did not influence the survival and viability of surface soil sclerotial inoculum (Table 1). It was implemented to establish environmental and microclimatic conditions at the soil surface and within the plant canopy that were unfavorable for the growth and pathogenic activity of *Sclerotinia*, especially in the spring when apothecia are producing ascospores (3).

Effect of cultural control practices on seed yield. Seed production was increased in the fall burn (862 kg/ha) and spring mowing plots (716 kg/ha) by 43 and 18%, respectively, when compared with the standard practice of winter burning (609 kg/ha).

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