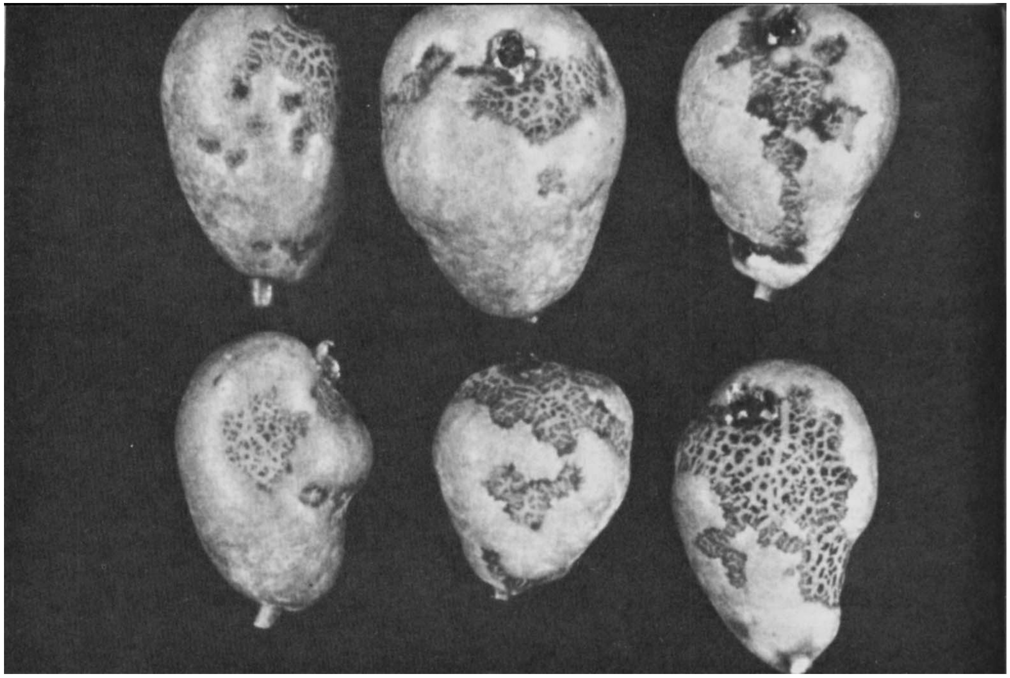

Fig. 1. Pear fruits severely disfigured by primary scab infection.

MONITORING PEAR

B. E. BEARDEN • W. J. MOLLER • W. O. REIL

Pear scab (*Venturia pirina*) has become more prevalent in recent years in the north coastal regions, especially in Mendocino County. A closely related fungus causes apple scab (*Venturia inaequalis*) but does *not* affect pears, although the life cycles, infection requirements, and even control measures for apple and pear scab are remarkably similar. While apple scab research is ample and worldwide in scope, the applicability of some of this research to pear scab in California has not been established.

The goals of this study were: to verify the emission periods of pear scab ascospores as related to pear growth stages and climatic factors; to test the reliability of the "Mills Tables" in determining infection periods and forecasting the appearance of symptoms; and to test the effectiveness of Benlate applied within 48 hours of an infection period.

In most of the state's pear districts, one or possibly two protective sprays at green tip and early bloom are the norm for pear scab control, but in the wetter coastal counties, additional cover sprays are needed, especially if wet weather persists after bloom. This early season period is when the scab protection game is often won or lost; heavy calyx infection of young fruits can create a problem that persists all summer long. A protective spray schedule, such as that typified by the grower program described here, is based on continuous before-infection coverage of rapidly expanding leaf and fruit surfaces.

The practical value of determining scab infection periods depends on the availability of fungicides with eradicant or back action; that is, chemicals that can be applied effectively *after* an infection period has occurred. Monitoring of spore emission and weather data makes this possible.

The source of spring infection

The pear scab fungus overwinters in two ways: 1) most important, in infected leaves that drop in the autumn, or 2) as twig infections on current season's shoot growth. These small lesions are hard to find, unless pear trees have been severely affected by scab.

Once the leaves have fallen, the scab fungus grows through the dead leaf tissue on the ground (fig. 2), producing fruiting bodies or spore sacs which contain the primary ascospores. As these primary spores mature in spring—at a time that coincides closely with early growth stages of the pear tree—they are shot forcibly into the air when rain falls. The spores are only discharged a fraction of an inch above the litter on the ground, but this enables them to be picked up by air currents and carried to nearby trees. If they find their way to newly exposed green tissue on the tree, and suitable moisture and temperature conditions prevail, the spores germinate and infect directly through the pear skin. Scab lesions become evident usually one to two weeks after infection. In these first scab lesions, secondary spores or conidia are produced. After the supply of primary spores in the fallen leaves has become exhausted, the secondary spores may extend the infection cycle until hot, dry weather prevents further development. However, if primary scab is bad and the orchard is irrigated by sprinklers which keep trees wet for long periods in early summer, secondary pinpoint scab can be a continuing problem.

Historically, pear scab has only been of sporadic importance in this state and we know of no report or detailed study relating pear scab spore catches to weather factors and bloom stages in California pear districts. Such information is essential to effective scab forecasting and timing of fungicide treatments.

Procedure

During the spring of 1975 a pear scab monitoring station was set up in a Potter Valley orchard in Mendocino County. The station consisted of a Burkard seven-day recording volumetric spore trap, a DeWitt seven-day recording surface wetness recorder and a sheltered seven-day recording hygrothermograph. The spore trap, operating with its orifice approximately 20 inches above ground level (fig. 3) was "baited" with old scab-infected pear leaves collected from beneath nearby trees which were unsprayed in the previous season. The leaves were spread on the ground in a 3 to 5 feet radius around the trap and kept in place by nylon mesh pegged securely on top. The wetness recorder and hygrothermograph were both situated 5 feet above ground level, near the spore trap. The amount of rainfall was determined from data collected at the Potter Valley Power House one mile from the orchard. Traces of rain not recorded at the Power House were detected on the wetness recorder.

Fig. 2. Diseased leaves overwintering on orchard floor; scab lesions from previous season's infection are clearly visible.

SCAB in Mendocino County

Operation began in late February just ahead of pear bud movement and continued over three months until early June when primary (ascospore) emission had ceased. The electric air pump which served the spore trap delivered 10 liters/minute of suction through the trap orifice. Hourly counts of ascospores were possible after staining and mounting weekly tapes from the trap; counts were made by traversing across the width of the tape with a light microscope objective using 40X magnification. The distinctive shape and size, 11-15 X 5-7 μm, of the ascospores (fig. 4) made their identification relatively simple. Primary spores were first detected near pear tree "green tip" in early March. Despite heavy rains during the remainder of that month, spore numbers stayed reasonably low until April. Maximum catches were recorded between full bloom and petal fall.

Night-time pear scab spore catches were proportionately lower than daytime, but primary spores were frequently detected in the trap during the hours of darkness. This occurrence contrasts with the apple scab fungus which releases very few spores at night. In calculating early-season apple scab infection periods, it is often possible to ignore the hours of wetness at the beginning of a wetness period if they occur at night because so few spores are emitted. Apparently this is not the case for pear scab. Daily spore catches were recorded in spores/m^3 and their correlation with rainfall is shown in fig. 5.

Infection periods

It was assumed that the Mills Tables originally derived for apple scab disease are applicable to pear scab and "infection periods" were calculated from these (table 1). An infection period was defined as "the time the pear surface tissue remains wet long enough, under suitable temperatures, to allow spore germination and penetration deep enough so that external moisture is no longer needed."

As soon as pear bud growth has commenced and primary spores had been detected by the trap, infection periods were calculated from table 1. If the wet periods were intermittent, their durations were totaled until there was a period of at least six hours of continuous dryness registered on the wetness recorder. If this dry period was sunny, and drying was quick and thorough, it was assumed that six hours after the trees dried the danger period had passed. If the drying was slow, and humidity remained high, then the six-hour dry period was extended by a safety margin of three to four hours.

Spray applications

Spring weather in California pear districts often includes prolonged dry spells which could enable growers to take advantage of any eradicant or "kick-back," as well as protectant properties of certain scab fungicides. Both Benlate and Cyprex are reputed to offer this advantage, which makes them valuable for use soon after the end of an infection period. To test out this hypothesis, a block of 54 Bartlett pear trees adjacent to the scab monitoring station was divided into 18 three-tree plots which received different scab control treatments in the spring of 1975. The three treatments were: A. grower protectant schedule;

B. experimental eradicant schedule based on monitoring data; and C. unsprayed check.

The grower protectant schedule (A) consisted of a green tip, lime sulfur application, followed by a wettable sulfur spray and 12 sprays of Cyprex at 1/2 pound/100, the latter applied every other tree row at 3 to 4 day intervals (eight complete applications). The experimental eradicant schedule (B) consisted of Benlate 1/2 pound/100 handsprayed immediately after the first, third, and fourth infection periods. (The second infection period occurred soon after the first; therefore, it was possible also to utilize the forward protective action of the Benlate at that time.)

There were 18 trees per treatment and these were divided into six replications of three-tree plots. The grower's program was applied with a standard orchard spray rig and it was only possible to completely randomize plots subjected to treatments B and C , thus the grower treatment is not amenable to a standard statistical analysis. Assessment was made by randomly sampling 100 fruits on each of the 54 trees in early summer and counting the scabby ones.

In the month of March, 14.6 inches of rain fell in Potter Valley and, according to the Mills Tables, two periods of "heavy" scab infection occurred during that period. However, the spore trap records showed that primary spore emission was very low during March; subsequent observations verified that resultant visible scab was minimal after these two infection periods.

The third infection period on April 3 and 4 was borderline according to the Mills Tables and therefore categorized as a "light" infection. By contrast with the earlier infection periods, however, this one was accompanied by more than a tenfold increase in the volume of spores detected in the trap. Subsequent observations suggest that little if any infection also occurred from this period of wetness and the Mills Tables prediction of a "light" infection period was conservative.

The fourth infection period between April 22 and 24 was defined as a "heavy" infection: it was accompanied by the highest spore release recorded for the season. Ten to twelve days later, on May 4, the first velvety scab lesions were observed on fruits of untreated pear trees.

Fig. 3. Spore trap station in Potter Valley pear orchard 1975. Bags in background contain infected leaves for "baiting" spore trap.

Conclusions

During 1975, in the Potter Valley area of Mendocino County, pear scab primary spore emission was very low through March, which encompassed the growth period from green tip to 1 percent bloom. Although infection was predicted during March, based on temperature and wetness data, no detectable scab developed, apparently because of limited primary spore emission (see fig. 5).

Primary spore emission increased with each successive rain and reached a peak on April 22 to 24 when a predicted "heavy" infection period resulted in 12 percent infected fruit on unsprayed trees. Benlate sprays applied up to 48 hours after the predicted infection period were effective in preventing scab infection.

The Mills Tables appear to give a reasonably accurate, though possibly conservative, guideline for predicting pear scab infection under Mendocino County conditions.

These preliminary data suggest that considerable savings in spray materials could be made in some Bartlett pear districts of California and studies are continuing.

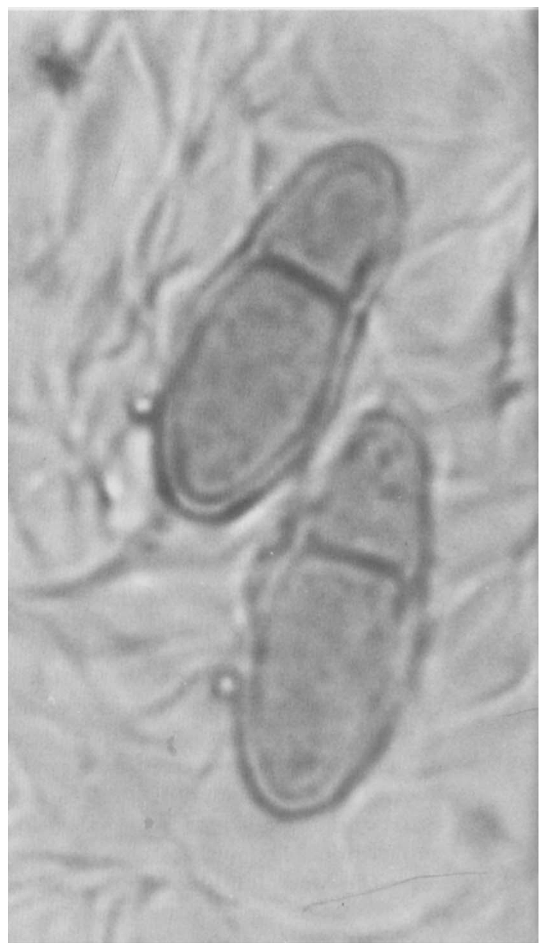

Fig. 4. Primary ascospores of the pear scab fungus collected on spore trap tape. Note their characteristic foot print shape.

B. E. Bearden is U.C. Farm Advisor in Mendocino County; W. J. Moller is Extension Plant Pathologist, U.C. Davis; and W. O. Reil is Staff Research Associate, U.C. Davis. *The authors acknowledge the assistance of J. March, Potter Valley pear grower, and P. Montoya in conducting these studies.*

TABLE 1. CALCULATING PEAR SCAB INFECTION PERIOD [DERIVED FROM SIMILAR TABLES IN CORNELL EXT. BULL. NO. 711 (1954) BY MILLS AND LA PLANTE]. HOURS NEEDED AT VARIOUS TEMPERATURE LEVELS UNDER CONSTANTLY WET CONDITIONS FOR PRIMARY SPORES TO CAUSE INFECTION.

	Wetness time in hours		
Temperature (°F)	Light scab infection	Medium scab infection	Heavy scab infection
33 to 41	Over 48	—	—
42	30	40	60
45	20	27	41
48	15	20	30
50	14	19	29
52	12	18	26
55	11	16	24
58	10	14	21
60	9.5	13	20
62	9	12	19
63 to 75	9	12	18
76	9.5	12	19
77	11	14	21
78	13	17	26

Average temperature of first five days after germination of ascospores (°F)	Number of days before scab spots become visible to naked eye
35 to 37	19
38 to 40	18
41 to 43	17
44 to 46	16
47 to 49	15
50 to 53	14
54 to 56	13
57 to 59	12
60 to 62	11
63 to 65	10
66 to 68	9
69 to 72	8
73 to 74	7

Quick assessment:
(Mean temperature - 30) X hours wet = 300 (light infection)
= 400 (moderate infection)
= 600 (heavy infection)

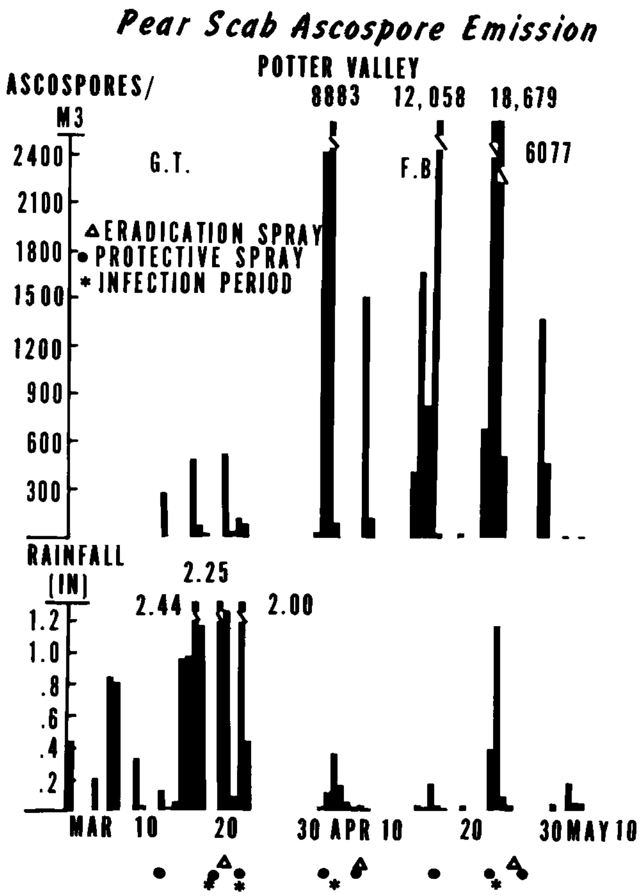

Fig. 5. Ascospore emissions and rainfall during the spring, 1975 season at Potter Valley, California. The four infection periods (using the Mills Tables) as well as the eradication and protective spray applications are also indicated.

TABLE 2. COMPARISON OF THREE SCAB CONTROL PROGRAMS AT POTTER VALLEY—1975.

Treatment	Replication (Total scabby fruit/300) 1	2	3	4	5	6	Average percent scab
A. Grower protectant schedule (8 applications)	0	1	0	0	0	0	0.07
B. Experimental eradicant schedule (3 applications)	1	6	0	0	0	1	0.43
C. Unsprayed check	13	22	12	45	39	91	12.3