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How to recognize and control

APPLE SCAB

COOPERATIVE EXTENSION SERVICE
Michigan State University

Fig. 1. Apple scab lesions produced on the underside of the leaves, showing their indefinite outline.

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The apple scab fungus *(Venturia inaequalis)* is found in all the apple growing areas of the state. If it is not controlled, a grower can lose most of his crop by reduction of yield and quality.

Yield reduction can result by one or more means. Infection of the stem (pedicel) of young developing fruit will cause premature drop. Severe leaf infection will result in leaf drop, which in turn reduces fruit size. Reduction of leaf surface results in poor bud development, which in turn reduces the next year's crop.

Fruit quality is decreased by size reduction, deformed fruit, and scabby appearance. Scabby fruit have a short storage life as well as a low marketing grade.

SYMPTOMS

Some individuals have difficulty in recognizing scab, particularly in the early stages of tree growth.

LEAF

The first leaf symptoms are found on the flower bud leaves. Olive green, irregular lesions appear on the under surface of the leaves, as this is the first surface exposed when the buds open during early infection periods (Fig. 1).

Typical leaf scab lesions are also found on the upper surface of leaves. The young lesion is olive green and indefinite in outline (Fig. 2). As it becomes older, it has a definite outline, and is olive green with a velvety surface. Later the velvety surface disappears and the leaf area under the lesion is often raised.

Severe early leaf infection can result in dwarfed, curled leaves with dead margins. This is accompanied by leaf drop later.

SEPAL

Primary fruit infection may occur on the sepals (green portions) of the flower bud early in the growing season. These structures are the first susceptible tissue to be exposed. The lesions are difficult to see because they are gray and indistinct.

FRUIT

Typical fruit scab lesions are distinct, almost circular, velety and olive green in color with the cuticle (outer waxy layer) ruptured at the margin. Older

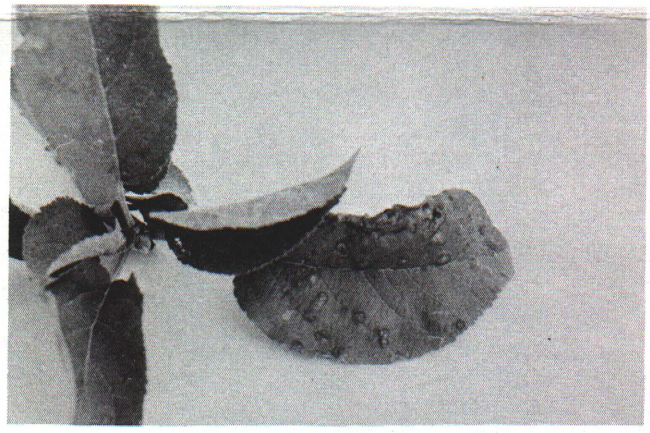

Fig. 2. Typical scab lesions on upper leaf surface.

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Fig. 3. Fruit that shows scab lesions on the side and calyx end. Note the crack, a result of scab infection.

lesions are darker, scabby, and often cracked (Fig. 3).

Twigs, blossoms, and bud scales can also be attacked by this fungus, but such infection is uncommon in most areas.

LIFE CYCLES

To carry out a sound scab control program, one must understand the life cycle of the fungus that causes the disease. By knowing this information, the control can be directed to the weakest part or parts of the life cycle.

The life cycle of the apple scab fungus consists of 2 cycles: (1) Primary, (2) Secondary. Follow Figure 4 when reading the following text on the life cycle.

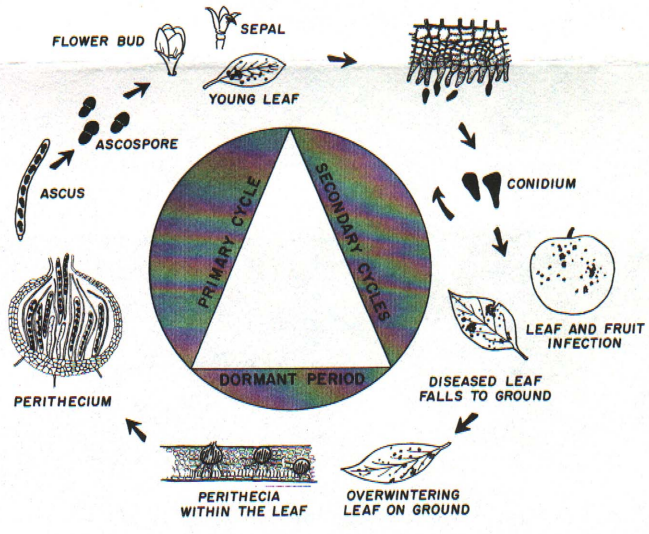

Fig. 4. Life cycle of the apple scab organism.

PRIMARY CYCLE

The fungus overwinters in the diseased leaves on the orchard floor. In the late winter, fruiting structures (perithecia) are formed in these fallen leaves. About bud break, spores (ascospores) begin to mature in the spore sacs (asci) within the perithecia. This maturity of ascospores usually extends 3 to 5 weeks after petal fall. This period can be reduced or extended, depending on weather conditions. In dry springs, it will be extended.

Rainy periods sufficient to wet the fallen leaves will cause a chemical reaction within the spore sacs. Increased internal pressure generated by the reaction elongates the sac so it extends out of the perithecial opening and the mature ascospores are then discharged.

Spores start to discharge 5 minutes after leaf moistening, and reach their maximum in 30 minutes. Ascospores are discharged only a fraction of an inch above the overwintering leaf. Wind and air currents carry the spores to the susceptible tissue close by or at a distance.

Ascospores mature over a period of time. If there is no rainfall early in the season, the spores continue to mature in the perithecia and a large discharge can be expected during the next wetting rain.

Moisture must be present for several hours around the spore and plant parts before infection can take place. Infection time varies with the temperature (See Table 1) under moist conditions. It is possible to have infection at low temperatures if the plant parts remain wet during this period.

On reaching the wet, young leaves and fruit, the ascospores germinate, penetrate, and send out thread-like structures (mycelia) within the cuticle. From this mass of mycelia, short upright stalks (conidiophores) are produced which bear summer spores (conidia). Table 2 indicates the time it takes for conidia to develop at different temperatures following primary infection. Development of the conidia begins the secondary cycle.

TABLE 1—The approximate number of hours of continued wet foliage required for primary apple scab infection at different air temperature ranges

Average air temperature range during wet period	Number hours continued wet period required for primary infection
32°—40° F.	30 hours
40°—42° F.	20 hours
42°—45° F.	14 hours
45°—50° F.	12 hours
50°—53° F.	10 hours
53°—58° F.	9 hours
58°—76° F.	11 hours
76°—	

TABLE 2. The effect of temperature following primary apple scab infection on the length of time required for the development of conidia (summer spores)

Average temperature following primary apple scab infection	Approximate time for summer spores after primary infection
30°—40° F.	18 days
41°—45° F.	16 days
46°—50° F.	14 days
51°—55° F.	13 days
56°—60° F.	12 days
61°—65° F.	10 days
66°—70° F.	8 days
71°—75° F.	7 days

(After W. D. Mills, Cornell Univ.)

SECONDARY CYCLE

Under ideal conditions, both the primary and secondary cycles may occur simultaneously early in the growing season.

Table 2 shows that conidia can form at low temperatures. Conidia are firmly attached to the conidiophores and are separated only when wet. These spores are spread abroad by rain, driving rain, or dew. The conidia are usually spread within the tree. Conidial infection requires about two-thirds of the time required for primary infection, as indicated in Table 1.

This cycle consists of infection by conidia, followed by production of conidia at or near the point of infection. There can be several secondary cycles in a season if this fungus is not controlled.

Storage scab is a result of infection occurring late in the summer during long rainy periods. The fruit is more resistant to scab at this time and the scab lesions develop very slowly. They often do not appear until the fruit is in storage.

Storage scab appears as black, shiny, smooth lesions. The cuticle usually remains intact. There is no cork layer under storage scab lesions.

CONTROL

Resistance—Although varieties vary in their susceptibility to the apple scab organism, no cultivated commercial variety has sufficient resistance to eliminate the need for chemical sprays. Research work in breeding for apple scab resistance has been initiated in a number of countries. However, the outcome of this project will not be known for several years.

Sanitation—Destruction of the fungus in the diseased leaves on the ground by spraying during the dormant season has been practiced in some areas of the country, followed by a regular spraying program.

In Michigan, it is suggested that, if a grower does a *thorough and timely* job in spraying, this additional dormant ground spray is not necessary. Even if 99 percent of the fruiting bodies (perithecia) are killed by a ground spray, the remaining 1 percent are sufficient to produce a severe scab infection under ideal weather conditions.

Management—Pruning, adequate equipment, proper rate of sprayer travel, and other production methods and equipment help give effective spray coverage of trees.

CHEMICAL SPRAYS

The apple grower is dependent on chemical sprays to control apple scab. The key to an effective apple scab control program is to spray according to rainfall (wetting periods) during the primary cycle (See Fig. 1). If this disease is not controlled at this time, a grower is forced to spray during the summer.

Classification of Fungicides

Four types of chemical apple scab sprays are: (1) **protectant,** (2) **eradicant,** (3) **combination of ½ strength eradicant + ½ strength protectant,** and (4) **protectant-eradicant.**

Protective—Lime-sulfur, wettable sulfur, sulfur paste, Ferbam, Glyodin, Captan, Dichlone (Phygon), Dodine (Cyprex).

Eradicative—Lime-sulfur, Dichlone (Phygon), Dodine (Cyprex), Captan.

Mixtures (both eradicative and protective)—Sulfur, Ferbam, Glyodin, or Captan, at half-strength combined with half-strength Dichlone (Phygon).

Protectants-eradicants—Lime-sulfur, Dichlone (Phygon), Dodine (Cyprex), Captan.

Protectant sprays are applied before rains or before infection takes place. Generally, they are milder and do not cause plant injury as do eradicants. The protectant spray sets up a chemical barrier between the susceptible tissue and the germinating spore.

Eradicant sprays "burn" out the fungus within a certain period of time after infection. These sprays include lime-sulfur effective for 72 hours after infection (See Figure 5) and are suggested for application up to pre-pink sprays. Dichlone (Phygon) is effective 48 hours, and Cyprex (Dodine) 36 hours after infection at recommended full strengths in the pre-cover sprays.

Half-strength Phygon eradicates 24 to 30 hours after infection (Table 4).

In recent years, with the introduction of chemicals with both protectant and eradicant properties, many apple growers spray on a 5-to-7 day schedule during the primary infection period. The length of spray interval depends on the amount of rainfall and growth

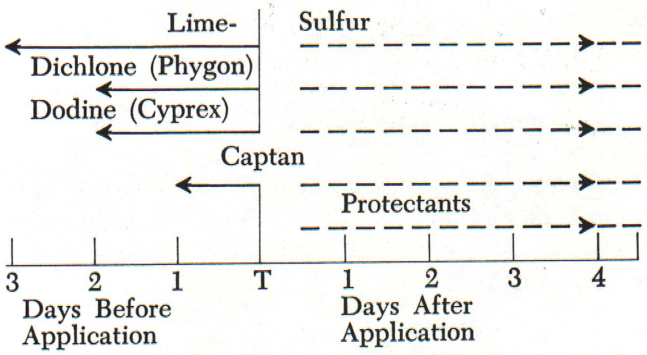

Fig. 5. Approximate periods of control of apple scab by different kinds of fungicides at full strength. (T = time of application.) The time to the left of the vertical line indicates the approximate period of eradicative action; that to the right indicates the approximate period of protective action. (After D. Cation).

during this time. The compounds used in this manner are Dichlone (Phygon), Captan, and Dodine (Cyprex).

The main disadvantage of this method is that in dry years an excessive number of sprays will be applied as compared to schedules based on rainfall and infection periods.

Growers should keep track of the start of a rain and average temperature and calculate from Table 1 the length of time it takes for infection to occur. For example, at an average temperature of 58° F., it takes nine hours for primary infection to take place after the start of a rain. This indicates that, if a protective spray is not applied before or within this 9-hour period, you must rely on an eradicative application. Whether a half-strength or full-strength eradicant is used will depend upon *how many hours after infection you apply the spray.*

Most growers consider the start of the rain as the beginning of the "infection" period, to insure themselves additional time to spray their orchards. This allows them several hours before actual infection takes place.

Ground dusting and airplane spraying and dusting are other methods being used in many areas, either as complete or supplemental schedules for scab control. The principles of proper coverage and timing apply here as in ground spraying (Fig. 6). If they are observed, good commercial scab control will result. Some of the more common chemicals used as dusts are Dichlone (Phygon), Captan and Dodine (Cyprex). The percentage active ingredient will vary with the environmental conditions and length of infection periods.

Commercial Growers — For a complete schedule for control of apple pests, see M.S.U. Extension Bulletin 154, Fruit Spraying Calendar.

Home Apple Orchard — Bud break to 3-5 weeks after petal fall: Captan 2 tablespoonsful per gallon of water at 5-to-7 day intervals.

Summer Sprays: Captan 1½ to 2 tablespoonsful per gallon of water at 14-day intervals or when insecticides are applied.

For a complete home orchard apple spray schedule, see M.S.U. Extension Folder F-17, *Pest Control Program for Home Grown Fruit.*

TABLE 3. SOME PROPERTIES OF APPLE SCAB FUNGICIDES

	Rate Per 100 Gallons of Spray	Retention	Redistribution	*Eradication from Beginning of Infection Period
Captan 50% WP	2 lb.	Fair	Fair-Good	18-24 hours
Dichlone (Phygon) 50% WP	½ lb.	Fair	Fair	36-48 hours
Dodine (Cyprex) 65% WP	½ lb.	Good	Good	30-36 hours**
Ferbam 75%	2 lb.	Good	Good	0
Glyodine 30%	1 qt.	Good	Poor-Fair	0
Sulfur 95%	5 lb.	Fair	Good	0
Lime Sulfur	2 gal.	Good	Good	60-72 hours

**Based on average temperatures of 50 to 60° F. Growers should use beginning of rain as start of infection. If average is 60 to 75° F, use the lower eradication time figures. For average temperatures lower than 50° F, use higher eradication time figures.*

***Our research has shown that Dodine at ½-pound rate will eradicate up to 48 hours after infection. This is suggested on a trial basis until the Dodine (Cyprex) label is changed.*

***Retention**—Ability of a chemical formulation to adhere to leaf and fruit surfaces during a rainy period, in order to continue protection against scab infection for the next infection period.*

***Redistribution**—Ability of a chemical to move during a wet period to give added protection to some of the neighboring unsprayed tissues.*

Note: A. Do not consider redistribution as a substitute for a complete spray application, especially in questionable infection periods. B. See fruit spraying calendar, Ext. Bul. 154, for suggested rates, timing, and safeness for the different fungicides.