



FUNGAL LEAF SPOTS OF BLACK WALNUT

Several important fungal leaf spot diseases of black walnut commonly occur in the Midwest. Walnut anthracnose, caused by the fungus *Gnomonia leptostyla* (imperfect stage *Marssonina juglandis*), is the most serious foliar disease of black walnut (Figure 1). The anthracnose fungus also attacks butternut, Persian (or English) walnut, Hinds walnut, and California walnut.

Losses from walnut anthracnose result in:

1. Premature defoliation, reduction in growth, and loss of ornamental value (Figure 1).
2. A weakening of the affected tree, making it more susceptible to other diseases.
3. Poorly-filled nuts (ambers) caused by a shriveling of the nutmeats, resulting in a lower grade and reduced value.
4. Premature nut drop if immature nuts become infected.



Figure 1. Walnut anthracnose (*Marssonina juglandis*).

Three other foliar pathogens of black walnut cause diseases of lesser importance. The fungus *Mycosphaerella juglandis* (imperfect stage *Cylindrosporium juglandis*), reported from Iowa to North Carolina, causes a small angular leaf spot. The fungus *Microstroma juglandis*, which occurs throughout the Midwest, causes a white mold or a yellow-leaf blotch. The fungus *Grovesinia pyramidalis* (imperfect stage *Cristulariella moricola*), reported to occur only in southern Illinois and Ohio, causes a bull's-eye or zonate leaf spot.

All defoliation of black walnut trees is not due to leaf-spot diseases. The leaves on trees growing on poor sites or suffering from drought may also turn yellow and drop during August and September. These leaves may be scorched at the margins or between the veins or may have tiny brown areas, but are not typical of the lesions produced by any of the following four fungi.

Symptoms

1. *Anthracnose* symptoms appear on the leaflets as small, circular to irregularly shaped, brown-to-black areas averaging 5 millimeters in diameter, often surrounded by a yellowish halo (Figure 2A). One

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or more lesions may develop on a leaflet and the spots may later merge to form large, blighted areas (Figure 2B). Very small black bumps, fruiting bodies (Acervuli) of the anthracnose fungus, are abundant on older lesions, especially on the underside of the leaflet near the veins (Figure 3). The acervuli can easily be seen with a hand lens.

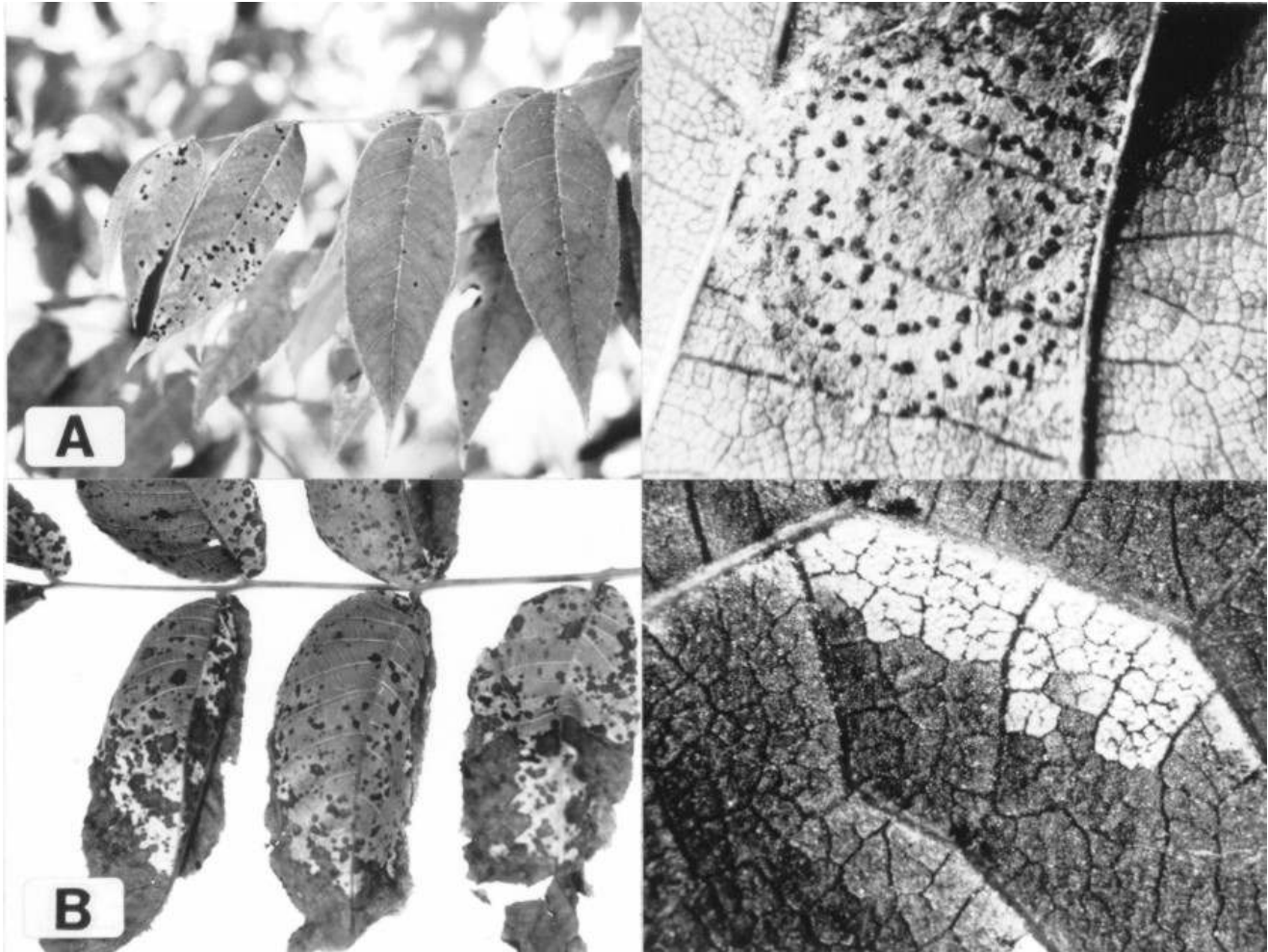


Figure 2 (Left). Walnut anthracnose lesions on the upper leaf surface: (A) early stage; (B) late stage. Figure 3 (Top Right). Acervuli on the lower surface of a walnut anthracnose lesion. Figure 4 (Bottom Right). Yellow-leaf blotch on the lower surface of a walnut leaflet. The white growth between the veins is composed of sporodochia on which spores (conidia) are borne.

Affected leaflets may turn entirely brown and drop early, thus reducing shoot growth and increasing the tree's susceptibility to other diseases. The nuts and current-season shoots may also become infected. Black, somewhat sunken flecks form on the fruit husks. The nuts with diseased husks may have dark, shriveled, unattractive meats. Infected, immature nuts do not develop normally and many drop prematurely.

Lesions produced on current-season shoots are rare, appearing as oval to irregularly circular, sunken, light grayish-brown areas with dark reddish-brown margins. The fungus also attacks the leaf rachis, producing lesions similar in appearance to those on the leaflets.

2. *Mycosphaerella leaf spot* at present has no common name. Although not as frequent in occurrence as anthracnose, the disease can cause extensive late season defoliation. The individual lesions are smaller than anthracnose lesions (Figure 5A). They tend to be numerous on affected leaflets and arranged along veins (Figure 5B) or at the leaflet tip (Figure 5C). A chlorotic halo often surrounds

coalescing lesions. Fruiting of the fungus is evident only after the lesion is placed in a moist chamber or after a rain when white conidial masses exude. These spores are responsible for spread of the disease.

3. *Yellow-leaf blotch*, also called white mold or downy leaf spot, is common wherever black walnut trees grow. The disease is more unsightly than damaging. The fungus causes a yellow blotching on the upper leaf surface that ultimately becomes brown and dry. On the lower surface, the whitish growth of the fungus can be seen. This growth is usually confined to the area between the veins (Figure 4). The snow-white coating is composed of small white sporodochia of the yellow-leaf blotch fungus which burst through the epidermis and produce large numbers of microscopic spores (conidia). These spores are responsible for spread of the disease. Yellow-leaf blotch does not kill the leaf or cause defoliation.
4. *Bull's-eye leaf spot*, like anthracnose, causes premature defoliation (Figure 1). Affected leaves may have many roundish lesions ranging from 1 to 10 millimeters in diameter. Later, the lesions may merge to cover large surface areas. The small lesions are mostly white (Figure 6A), while the older and larger lesions are brown with raised, white, concentric rings giving the appearance of a target or bull's-eye (Figure 6B). Lesions along the veins tend to be wedge-shaped. Examining infected leaves with a hand lens, especially the lower surface, sometimes reveals cone- or pyramidal-shaped spores resembling miniature white "Christmas trees" (Figure 7).

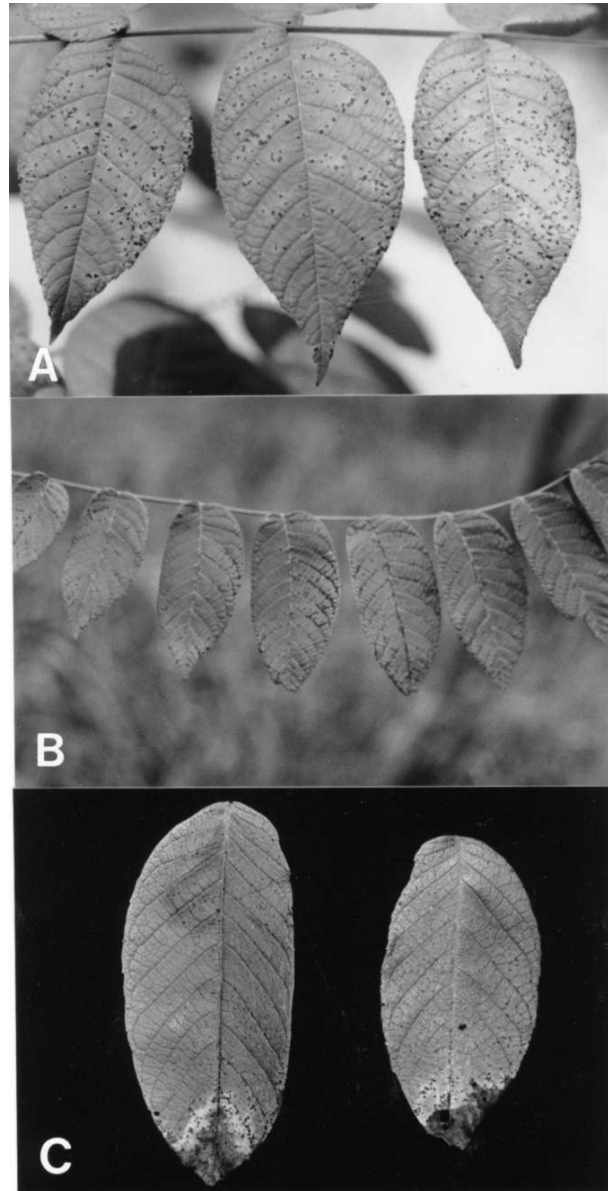


Figure 5. *Mycosphaerella* leaf spot of black walnut: (A) small scattered lesions; (B) lesions arranged in patterns along the veins; (C) leaf scorch of two leaflet tips (courtesy of Dr. K.J. Kessler, Jr.).

Disease Cycles

1. During the winter, the anthracnose fungus forms black specks (perithecia). Perithecial formation is favored by temperatures between 45° and 50°F (7° to 10°C). Two compatible strains (+ and -) are required to form the sexual, spore-bearing perithecia. Within each perithecium, many sac-like structures called asci develop, each containing eight ascospores. In wet spring weather, the ascospores are forcibly discharged from the perithecium and are carried by air currents to walnut leaves where infection occurs. Rain is important in spore discharge and dissemination. The optimum temperature for ascospore discharge is 50°F (10°C). In Illinois, ascospores produce infections from late April to early June. Ascospore discharge begins an hour after the start of a wet period, is greatest within 4 to 6 hours, and ends after 20 to 30 hours. Wind and rain splash carry the

spores to the new green leaves. Symptoms of anthracnose can be seen as early as late May.

Black acervuli form in lesions on leaves resulting from spore infections. Acervuli production is greatest at 65°F (18°C). The acervuli produce large numbers of microscopic, asexual spores (conidia). These spores give rise to secondary infections, which occur from late June until the fall. Rain splash is required for the spores to spread. Free moisture must remain on the leaf surface more than 6 hours for significant levels of infection to occur. The optimum temperature for infection is 70°F (21°C). Little infection occurs at temperatures above 81° to 86°F (27° to 30°C) and below 50° to 59°F (10° to 15°C). Symptoms develop 14 to 21 days after inoculation. Spores can remain alive on the leaf surface for at least two weeks, even if free moisture is not present.

The anthracnose fungus overwinters in fallen leaves as perithecia. More recently, perithecia embedded in the leaf stems have been suggested as being important because of the resistance of these structures to decay. The fungus may also overwinter as spores on walnut twigs.

Trees affected by anthracnose for one or two years are not usually damaged enough to noticeably affect growth. Trees affected for several successive years, however, may be stunted in growth and weakened.

2. The disease cycle for *Mycosphaerella* leaf spot is quite similar to that of anthracnose. The primary infections result from ascospores inoculum released in May and June. Conidia appear on primary lesions after 10 to 14 days. Extensive secondary spread of conidia occurs during July and August. The fungus overwinters in perithecia in fallen leaves.

3. The disease cycle of the yellow-leaf blotch fungus is not clearly understood. The causal fungus has no reported perfect stage and the fungus is believed to spread by air- and water-borne conidia. The disease first appears as leaves approach full size in late spring.

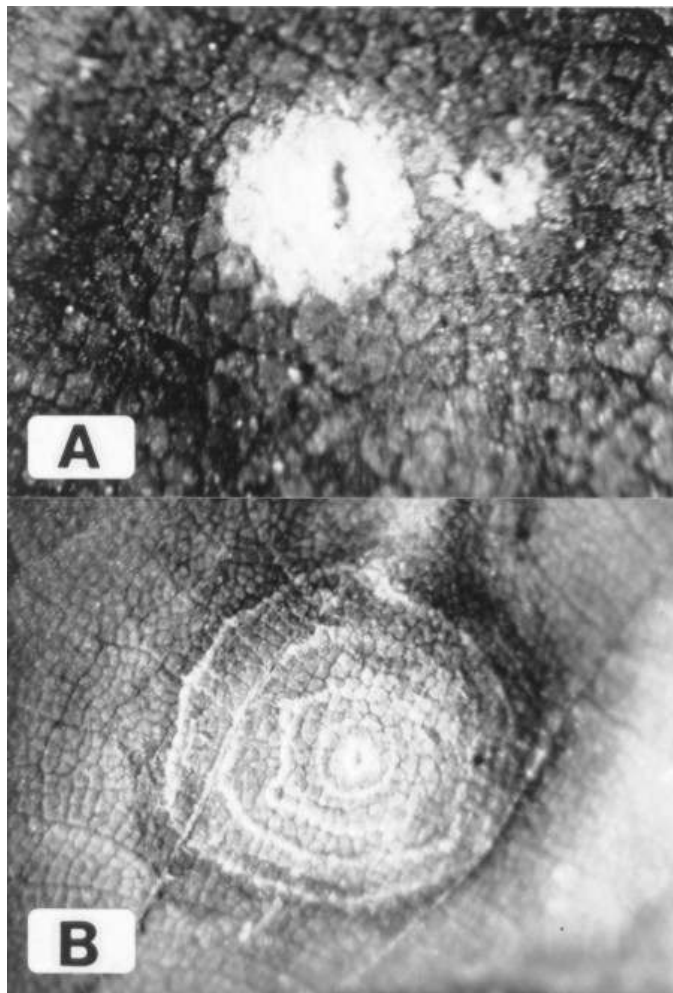


Figure 6. Bull's-eye leaf spot on the upper surface of a walnut leaf: (A) small lesion; (B) large lesion with raised, white concentric rings.



Figure 7. Pyramidal-shaped conidia of *Cristulariella pyramidalis* on the lower surface of a walnut leaflet.

4. Bull's-eye leaf spot is sporadic in flood-plain or bottom land plantations, appearing from mid-summer to fall. Extended periods of cool moist weather during mid-to-late summer seem to favor disease development. The fungus grows from 43° to 81°F (6° to 27°C). However, maximum sporulation and lesion development occur on moist leaves at 70°F (21°C).

Neither the overwintering site of the causal fungus nor the source of spores for spring infections is known. It appears that the pyramidal-shaped conidia serve as the source of secondary infections throughout the summer. The conidia are released following wind/raindrop agitation and are disseminated by gravity or rain splash. They have limited aerial dissemination. Lesion development is extremely rapid (2 to 4 days).

Control

No practical control of these fungal leaf spots is known for walnuts growing under forest conditions. In nurseries, plantations, home grounds, or parks, the control of anthracnose and other fungal leaf spots can be accomplished by:

1. Sanitation. Where feasible, fallen leaves should be gathered and composted or burned.

Several weeds are known hosts of the *Cristulariella* fungus. Weed control in and around planting sites should reduce early-season infections.

2. Planting Site. Walnut trees should be planted where air circulation is good. This helps the foliage to dry rapidly. Bottomlands where air movement is poor should be avoided.
3. Fertilization. Proper maintenance of soil fertility, based on a soil test, will significantly increase tree vigor and reduce the susceptibility to anthracnose. Nitrogen fertilization helps minimize the harmful effects of *Mycosphaerella*, *Microstroma* and *Grovesina*.
4. Spray Programs. Each grower should assess the need to control fungal leaf spots. Trees not severely defoliated every year by anthracnose are not harmed sufficiently to warrant spraying.