Diseases of Intensively Managed Eastern Black Walnut

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ABSTRACT—Eastern black walnut has few serious disease problems in its natural woodland setting. However, trees in plantations are subjected to various cultural activities that can create stand conditions that increase pathogen populations and abiotic injuries that often interfere with landowner's objectives.

Native diseases are largely a preventable threat to stands of eastern black walnut (*Juglans nigra*). Eastern black walnut grows naturally in small groups or scattered individuals on a variety of sites associated with assorted tree species of the central hardwood zone. It grows best on well-drained bottomland soils and in coves from the Midwest to the Appalachians. However, when large numbers of eastern black walnut are grown together and managed in plantations, poor site conditions, stress caused by weed competition, soil compaction, injuries from equipment, improper pruning, and wildlife, and adverse microclimatic conditions can predispose trees to fungal pathogens.

NURSERIES

Nurseries epitomize intensive management. The high density of seedlings in production beds and related microclimate conditions leads directly to potential high incidences of foliage and stem diseases and the buildup of inoculum in soil and seed borne pathogens. These conditions and pathogens can result in seedling mortality, weakened seedlings, or the inadvertent planting of infected nursery stock, that in turn can lead to plantation failure.

Root Diseases

Several root diseases have been reported that either kill nursery-grown seedlings outright or cause seedling losses in storage, or during shipping and handling. Disease incidence depends primarily on high soil moisture and the presence of pathogens in the nursery beds or adjacent areas. The fungi *Phytophthora citricola*, *P. cactorum*, *Fusarium episphaera*, *Cylindrocarpon radicicola*, *C. candidum*, *Pythium vexans*, and *Cylindrocladium* sp. have all caused seedling mortality (Berry 1973, Green and Ploetz 1979, Roth and Griffen 1979). Fumigation or treatment using soil chemicals can have short-term benefits, but inevitably beds are re-infested from nearby affected areas. Reducing standing moisture by growing seedlings in well-drained beds may minimize losses (Berry 1973, Kessler 1982).

Seed Borne Pathogens

Recently in Canada, eastern black walnut and butternut (*J. cinerea*) seed that were apparently infected by the butternut canker fungus (*Sirococcus clavigignenti-juglandacearum*) were sown in nursery beds resulting in cankers developing on the seedlings of both walnut and butternut. The entire crop of both species was destroyed to prevent long distance spread of inoculum by shipping the infected planting stock. The butternut canker fungus has been reported on mature eastern black walnut in natural stands, but the fungus has not caused as severe damage as on butternut (Ostry and others 1997).

PLANTATIONS

Walnut trees growing in plantations and the application of various cultural activities used in managing these trees can create stand conditions that increase pathogen populations and abiotic injuries that are often not present in natural stands so disease incidence and severity is usually greater in plantations.

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Stem Diseases

Most canker fungi need some type of opening in the bark in order to invade and infect susceptible tissues of trees. Wounds result from a variety of management activities, by wildlife and from several abiotic causes. Preventing wounds can minimize serious damage caused by many fungi. A few examples of walnut stem diseases; their cause and ways to minimize tree damage are discussed in the next sections.

Wounds Caused by People

Any open wound caused by equipment and improperly timed or poorly made pruning cuts can lead to infection by *Fusarium* spp., the cause of the annual walnut canker, or infection by the perennial target canker fungus *Nectria galligena* (Berry 1973, Cummings and Kuntz 1985, Cummings and others 1993). Pruning should be done properly (removing branches outside the branch collar area taking care to not tear bark below the collar) during the late winter, although anytime during the leaf-off period is acceptable (Bedker and others 1995).

Slow tree growth caused by grass competition results in inadequate or delayed natural pruning and may prevent rapid closing of pruning wounds. Herbicides will control weeds but soil compaction and mechanical wounds to trees associated with chemical applications may occur. Care should be taken to avoid operating equipment in the field during wet weather or in early spring when soils may be saturated to avoid soil compaction and root damage. Obviously, bumping trees with equipment and otherwise scraping off bark should always be avoided.

Wounds Caused by Wildlife

Damage to tree bark caused by deer rubbing their antlers and pecking of the bark by birds can cause tree damage directly as well as lead to infection by canker organisms. There are myriad products that claim to protect trees from deer damage. Various chemicals or physical barriers such as tree shelters can yield variable results. Experiment with a variety of materials to see what works best in your area.

There is little that can be done to protect trees from being fed on by the yellow-bellied sapsucker. It is a protected songbird and in large numbers can cause widespread damage. A possible approach is to leave trees in stands that have been attacked previously since the birds seem to be attracted to previously attacked trees, thereby minimizing damage to remaining trees.

Wounds Caused by Weather Extremes

In the northern extent of its range, and elsewhere in cold air drainages during severe winters, freeze damage causes dieback and mortality of the above ground portions of black walnut, often resulting in infection by *Fusarium* spp. causing annual cankers (Cummings and others 1993, Hayes 1995). This fungus is soil-borne and gains entrance through breaks in the bark anytime during the growing season.

In most cases, little can be done to protect trees from breakage caused by wind, snow and ice. However, timely corrective pruning can help trees survive and retain acceptable crown architecture while protecting them from breakage and subsequent entry by decay fungi.

Decay organisms will eventually infect aging trees, and trees with old branch stubs, large open wounds, and cankers. Eastern black walnut is host to several heart rot fungi. The two most common are *Phellinus igniarius* and *Laetiporus sulphureous* (Berry 1973). Maintaining tree vigor and preventing wounds is the best way to avoid damage by decay fungi.

FOLIAGE DISEASES

Foliage diseases are the most serious diseases of plantation eastern black walnut. Factors that lead to infection and increased disease incidence and severity are high humidity (> 98%), free moisture on leaves (rain, dew, fog, or from irrigation), low light intensity, and temperatures around 21° C. There are four common leaf diseases of black walnut, Microstroma white mold, bull's-eye leaf spot, Mycosphaerella leaf spot, and walnut anthracnose. The most common and most serious of these is walnut anthracnose (Weber and others 1980). All but Microstroma white mold can cause premature leaf loss resulting in reduced growth, increased susceptibility to other diseases, and reduced quantity and quality of nuts.

All of these fungal diseases have a similar biology. Primary infections occur in the spring, May through early June, from ascospores emerging from fruiting bodies on over-wintered leaves on the ground. Once primary infection occurs, lesions appear on leaves within a couple of weeks. Subsequent secondary infections occur on leaves throughout the summer by wind-dispersed spores (conidia) produced in these lesions. Production of spores increases gradually during July and reaches maximum numbers in August. The infected, fallen leaves serve as the reservoir for next year's inoculum, completing the annual life cycles of these fungi.

Microstroma White Mold

Microstroma white mold (or downy leaf spot), caused by *Microstroma juglandis*, is more unsightly than damaging. This disease does not kill the leaf and is not known to cause defoliation. The effect to the tree is minimal, probably resulting in a minor reduction in photosynthesis. Symptoms are a yellowish discoloration on the upper surface of the leaf, and a whitish growth on the underside of the leaf, often concentrated along the veins.

Bull's-Eye Leaf Spot

Bull's eye leaf spot (or zonate leaf spot); caused by *Grovesinia pyramidalis* (asexual state = *Cristulariella moricola*) causes leaf spots and premature defoliation. Maple, hickory and many common weeds are also infected. Symptoms are unique in that the dark lesions on leaves are rounded and have concentric white rings, giving the spot a target-shaped appearance, hence the name bull's-eye leaf spot.

Mycosphaerella Leaf Spot

Mycosphaerella leaf spot, caused by *Mycosphearella juglandis* (asexual state = *Cylindrosporium juglandis*) causes leaf spots that are angular, reaching a maximum size as large as 4 mm in diameter. By midsummer, lesions from secondary infections result in affected trees becoming chlorotic. Coalescing lesions produce a vein pattern or a leaf scorch symptom. By late summer, especially in dry weather, severely diseased leaves fall.

WALNUT ANTHRACNOSE

The most serious and widespread leaf disease of black walnut is walnut anthracnose, caused by *Gnomonia leptostyla* (asexual state = *Marssonina juglandis*). The disease results in leaf spots ranging in size from a few mm to 1.25 cm in diameter. Dark spots first appear on the leaf blades and petioles in the spring. The leaves infected early in the year are most important for photosynthesis during the critical period of nut formation and severe disease can cause reduced yield and nut crop failure. The fungus may infect the nuts directly, causing nutmeats to shrivel and darken. The older leaves in the lower and interior portions of the tree crown are most severely affected, show the most chlorosis and are the first to fall prematurely.

Adjacent trees in plantations may exhibit varying levels of disease, indicating existence of natural resistance to anthracnose. This resistance is highly heritable, with provenances from the relatively arid western edge of the natural range of black walnut (Kansas and Oklahoma) being most susceptible. This is likely due to the limited natural selection for anthracnose resistance in this region since disease incidence is much lower under arid conditions.

When evaluating differences among cultivars in susceptibility to anthracnose one must take into account the nut load (William Reid, personal communication). This is because non-fruiting shoots have more terminal leaves and these leaves have fewer anthracnose lesions because they matured later in the season after the primary infection period for the fungus had passed. Thus, a tree producing a large quantity of nuts will look more susceptible to anthracnose than a tree producing few or no nuts.

Control of Leaf Diseases

Most of the research on control and management of foliar diseases of black walnut has been directed toward walnut anthracnose, although many of the strategies available to growers probably would be effective against all the walnut leaf diseases.

Cultural management is the best approach to minimizing the impact of leaf diseases, particularly in plantations. First, if possible, plant only seedlings known to be resistant to disease. Presently, growers are at the mercy of nut collectors when buying seedlings. It is incumbent on nurseries to only sow nuts from known sources, preferably from resistant trees within the region where seedlings ultimately will be planted. Avoid shipping seedlings from the western area of the natural range of black walnut to other regions. In established plantations, growers should observe which seedlings exhibit symptoms and select against the most susceptible individuals during thinning operations.

Most cultural practices should be directed toward reducing free moisture on leaves. Dense stands are susceptible to disease because of increased humidity, caused by reduced wind flow through these stands, resulting in free moisture on leaf surfaces for extended periods of time. Thinning trees improves drying of leaf surfaces and reduces leaf shading between trees thereby reducing incidence and severity of disease (Tisserat 1985). Ponds, lakes and streams release heat gradually on cool nights, so establishing plantations near bodies of water, particularly on the lee side, lessens dew formation on leaves. Avoid establishing plantations in cold seeps or small openings since this leads to increased dew formation. If possible, avoid overhead

irrigation if moisture on leaves will be maintained for long periods of time.

Weeds can contribute to high relative humidity around seedlings, increasing leaf disease, so growers should control weeds either through cultivation or the use of herbicides. Cultivation after leaf fall has the added benefit of incorporating infected leaves into the soil, thereby promoting their decomposition and reducing pathogen populations.

Depending on the crop, intercropping may also contribute to increased humidity. Growers will have to weigh the risk of increased potential of leaf diseases versus the benefits of intercropping. Interplanting autumn olive, hairy vetch, crown vetch, or serecia lespedza may reduce infection by increasing total foliar nitrogen and by preventing primary infections due to increased decomposition of fallen black walnut leaves thereby lowering ascospore production.

April and June applications of nitrogen may reduce infection as well as increase growth of trees. However, according to W. Reid, high rates of nitrogen stimulate non-fruiting shoots to grow late into the summer well after the infection period. These leaves give the tree a healthy appearance and mask the defoliation of older leaves. Soil application of ammonium sulfate, ammonium nitrate, and urea all are effective, although foliar application of urea is not. The addition of phosphorus and potassium has been shown to diminish the benefit of nitrogen fertilizer.

Direct control using fungicides can be effective, although the availability of suitable materials is in question. Since the status of all agricultural chemicals is always under review, contact your local extension agent for the latest information. Infection can occur anytime during the growing season so timing of applications presents a problem. A practical approach is to use two applications: the first during the last week in May to prevent the primary infection by ascospores, and the second during the first week of July to inhibit secondary infection by conidia.

Overall, native insects and pathogens should not pose a significant threat to black walnut management. Planting quality seedlings from geographically suited seed sources, and taking care to avoid injurious management practices will result in healthy growing stock. Currently no known exotic pests threaten black walnut. Given the high amounts of global trade, and the frequent introduction of forest pests, plantings should be monitored closely since they can serve as an early detection network for potentially invasive and damaging pests.

LITERATURE CITED

Bedker, P.J.; O'Brien, J.G.; Mielke, M.E. 1995. How to prune trees. NA-FR-01-95. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area, State and Private Forestry. 12 p.

Berry, F.H. 1973. Diseases. In: Black walnut as a crop: 2nd Black walnut symposium; 1973 August 14-15; Carbondale, IL. Gen. Tech. Rep. NC-4. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 88-90.

Cummings, J.E.; Kuntz, J.E. 1985. Stem canker on black walnut caused by *Fusarium sporotrichioides*. Phytopathology 75:1279.

Cummings Carlson, J.; Mielke, M.E.; Appleby, J.E.; Hatcher, R.; Hayes, E.M.; Luley, C.J.; O'Brien, J.G.; Rugg, D.J. 1993. Survey of black walnut canker in plantations in five central states. Northern Journal of Applied Forestry. 10: 10-13.

Green, R.J.; Ploetz, R.C. 1979. Root rot of black walnut seedlings caused by *Phytophthora citricola*. In: Walnut insects and diseases workshop proceedings; 1978 June 13-14; Carbondale, IL. Gen. Tech. Rep. NC-52. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 5-10.

Hayes, E.M. 1995. Freeze injury to black walnut plantations in Minnesota during the winter of 1993-94. 86th Annual Report of the Northern Nut Growers Association: 21-27.

Kessler, K.J.; 1982. Control of black walnut root rot diseases in nurseries. Res. Pap. NC-228. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 8 p.

Ostry, M.E.; Katovich, S.; Anderson, R.L. 1997. First report of *Sirococcus clavigignenti-juglandacearum* on black walnut. Plant Disease. 81: 830.

Roth, D.A.; G.J. Griffen. 1979. Cylindrocladium root rot of black walnut seedlings: root rot of black walnut seedlings caused by *Phytophthora citricola*. In: Walnut insects and diseases workshop proceedings; 1978 June 13-14; Carbondale, IL. Gen. Tech. Rep. NC-52. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 11-21.

Tisserat, N.A. 1985. Foliage and stem diseases of black walnut. In: 76th Annual Report of the Northern Nut Growers Association: 121-130.

Weber, B.C.; Anderson, R.L., Hoffard, W.H. 1980. How to diagnose black walnut damage. Gen. Tech. Rep. NC-57. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 20 p.