COMPANION PLANTING OF BLACK WALNUT WITH AUTUMN OLIVE TO CONTROL MYCOSPHAERELLA LEAF SPOT OF WALNUT[1]

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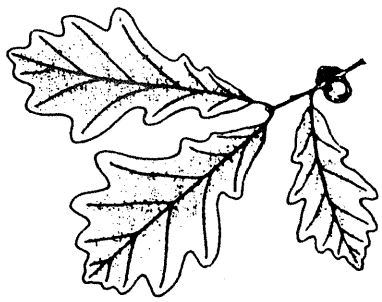

ABSTRACT.--When autumn olive (AO) was interplanted with black walnut (BW) in southern Illinois, lesion incidence and leaflet defoliation caused by Mycosphaerella juglandis were less than 1/10 those in adjacent monocultured BW control plots. Principal effects of interplanting were to reduce primary inoculum and to interfere with dissemination of primary and secondary inoculum. Ground shading by AO and later leaf-shedding by AO than BW in the fall apparently produced a ground microclimate that increased decomposition of infected fallen BW leaves and consequently lowered perithecial production from them. The AO leaf layer overlying fallen BW leaves prevented movement of ascospore inoculum into the atmosphere. During the summer, AO foliage impeded conidial spread from heavily infected foliage in adjacent BW plots to nearby plots containing companion-planted BW. Uninfected foliage on interplanted BW remained three or more weeks longer on the trees in late summer than on those grown in monoculture. Shading by AO induced earlier death of BW branches close to ground zone where humidity was higher and foliage was more susceptible to infection.

Because of increased growth of black walnut (up to 134 percent increase in height), mixed planting with autumn olive, Elaeagnus umbellata Thunb., has been suggested as a plantation cultural system, particularly for marginal walnut planting sites (Ponder 1982; Schlesinger and Funk 1977). Funk et al. (1979) observed that walnut when grown in the mixed plantings kept its foliage much later in the growing season. They speculated that this effect was related to a reduced incidence of anthracnose leaf spot caused by Gnomonia leptostyla (Fr.) Ces & de Not. A later evaluation of several of the mixed plantings during 1980 and 1981 verified that leaf spot incidence was greatly reduced on interplanted trees (Kessler, unpublished).

Reported here are (1) the effects of companion planting walnut and autumn olive on the incidence of Mycosphaerella leaf spot disease (Kessler 1984) at one planting site and (2) several disease control processes that could be in effect in mixed plantations.

MATERIALS AND METHODS

One walnut tree in each of four monocultured plots was randomly selected in the spring just as foliage was developing and before any Mycosphaerella lesions appeared. Four terminals on each of these trees were flagged and numbers of leaves and leaflets on them recorded. At the same time a nearby walnut tree in a companion-planted plot was also selected and measured in an identical manner. Twice monthly, total leaves, leaflets, and lesions were counted on the flagged terminals of the marked trees. Occasional comparisons of measured trees with other plot trees indicated that disease development within plots could be adequately measured by single-tree sampling.

Mycosphaerella juglandis Kessler perithecia are extremely difficult to locate and count on fallen infected leaves. The larger perithecia of Gnomonia leptostyla, causal agent of walnut anthracnose, however, are readily located and counted. To study the effect of companion planting on the development of primary spring inoculum of a leaf pathogen, leaflets containing numerous anthracnose lesions collected at another location were

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substituted for Mycosphaerella infected leaflets. These were divided into groups of ten and placed in nylon-screened enclosures at various microsites for overwintering within the planting. In the spring the leaves were regathered and counts of perithecia and the area of the ten largest surviving leaf fragments determined.

The ability of autumn olive foliage to retard the movement of spore inoculum through the atmosphere was studied with a system using either Septoria lycopersici Speg. conidia and potted Pixie tomato plants or G. leptostyla conidia and potted walnut seedlings. Mycosphaerella conidia were not used since they would have introduced an additional unnatural inoculum source into the plots. From the outside of mixed plantings on calm days 10 liters of spore suspension were blown into the plantings through autumn olive foliage with a Solo 423 mist blower. Spore concentrations were adjusted to fall within the range 4 x 10^4 to 2.3 x 20^5 spores per cc. Potted tomato plants and walnut seedlings to serve as trap plants were placed at various distances from origin of the inoculum (fig. 1B). Similar installations were set up on nearby monocultured walnut plots to serve as controls (fig. 1A). After the spores were dispersed, the seedling plants were allowed to remain in place until any spore suspension upon them had dried. They were then removed from the field. The plants were incubated for two days in a moist chamber and then in a greenhouse for two weeks. Lesions developing on the potted plants were counted and expressed as numbers per leaf or leaflets.

RESULTS AND DISCUSSION

Table 1 illustrates a typical sequence of lesion increase for 1983 similar to those recorded also for 1980, 1981, and 1982. Primary infections in May resulted in fewer than one lesion per leaflet on monocultured walnuts and no lesions on companion-planted walnuts. Although primary inoculum produced few infections in the monocultured walnuts, these initial infections were adequate to establish enough inoculum centers to initiate epidemics culminating in defoliation in August-Septmeber in the monocultured walnut (table 2). Companion-planted walnut maintained its foliage 3-6 weeks longer than monocultured walnut.

TABLE 1.--Mycosphaerella lesions increase during 1983.

(In numbers)

Time	Lesions per leaflet: Walnut monoculture	Lesions per leaflet: Walnut-autumn olive companion planting
May 9	0.02	0
May 20	0.23	0
June 10	0.32	0.07
June 24	1.65	0.11
July 8	10.82	0.88
July 22	24.73	2.42
Aug. 12	83.92	4.73
Aug. 26	117.68	5.17
Sept. 9	100% defoliated	7.28

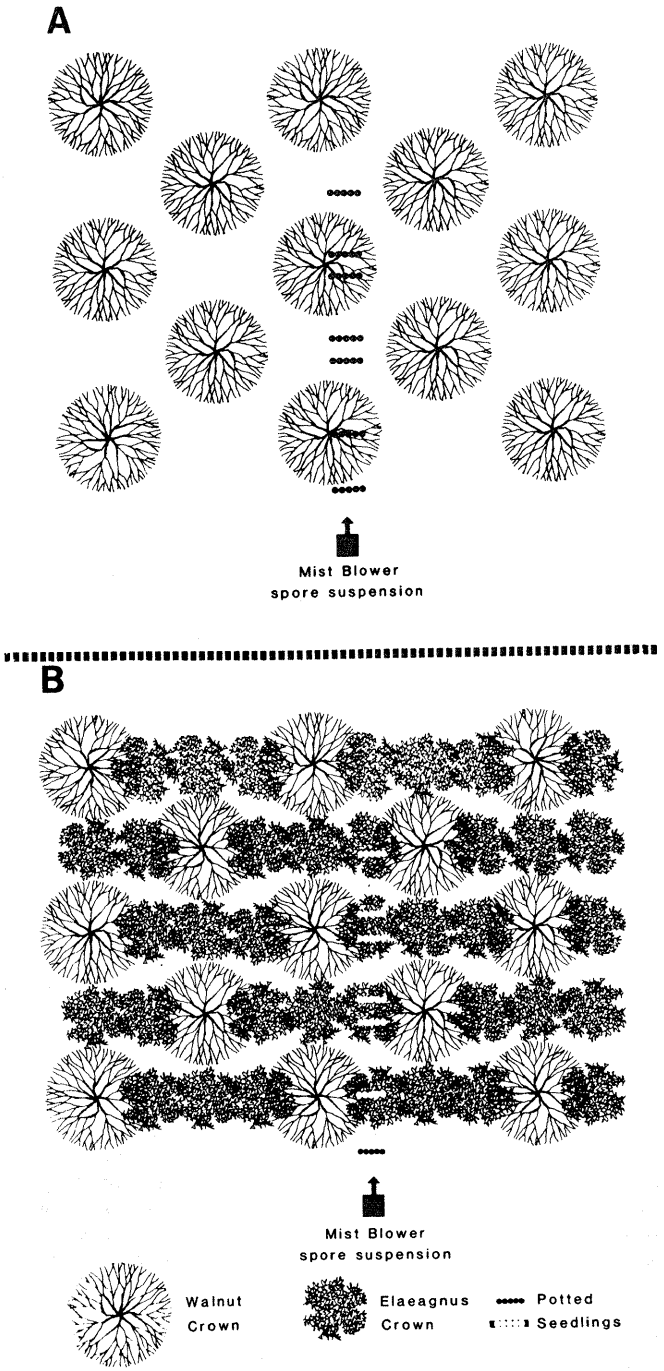

FIGURE 1.--Schematic representation of trap seedling arrangement in respect to mist blower spore source in (A) walnut monoculture plot and (B) walnut-autumn olive companion plot.

Production of Primary Inoculum

Location of infected leaves within the litter layer as well as the type of litter and whether the site is companion-planted or monocultured had important effects on production of perithecia. Placing infected walnut leaves under either autumn olive or fescue leaves reduced G. leptostyla perithecial production (table 3). A fescue covering reduced

perithecial numbers by 68 percent in monocultured and by 93 percent in companion-planted sites. While a covering of autumn olive leaves reduced perithecia more, contact of walnut leaves with autumn olive leaves below them also caused a reduction. This effect did not seem to be primarily microclimatic since it can occur in monoculture sites as well as companion-planted ones (table 3).

TABLE 2.--*Mycosphaerella* lesions per leaflet on monocultured and companion-planted black walnut during 1980, 1981, and 1982 growing seasons.

(In numbers)

Time	Walnut monoculture	Walnut-autumn olive companion planting
May		
1980	0.2	0
1981	0.3	0
1982	0.2	0
June		
1980	2	0.1
1981	10	0.2
1982	3	0.1
July		
1980	8	2
1981	36	6
1982	77	3
August		
1980	84	9
1981	102	16
1982	95	4
September		
1980	complete defoliation	10 (little or no defoliation)
1981	"	22 "
1982	"	6 "

Dissemination of Primary Inoculum

The ascospores of *Mycosphaerella juglandis* are small, non-distinctive and not readily identifiable in spore traps in the field. Because of the inability to easily determine aerial populations of the ascospores, it has not been possible to directly determine how important interplanting is in creating physical barriers to spore movement from the ground zone to the walnut leaves. However, the lack of primary infections in the interplanted plots in May (table 2) suggests that little or no lateral movement of ascospores from adjacent walnut monoculture plots is occurring.

Dissemination of Secondary Inoculum

In experiments where *Septoria lycopersici* or *Gnomonia leptostyla* conidia were blown through plantation foliage, autumn olive foliage had a filtering effect (tables 4 and 5). Trap seedlings placed at the edge of companion plots in front of the first row of autumn olive caught more conidia than at similar distances in monoculture plots. This appeared to be a rebounding effect, caused by the impaction of the spore suspensions as they encountered the dense autumn olive foliage. On the other side of this foliage (table 4--6.5 m; table 5--4.7 m) lesion numbers on the trap seedlings were sharply reduced. In the monoculture plots there was no sharp falling off of lesion numbers at this distance. In the monoculture plots (table 5), *G. leptostyla* conidia moved a distance of 13 m (43 ft). In contrast, in the companion plots nearly all *G. leptostyla* conidia failed to reach 8 m (26 ft).

TABLE 3.--Effect of treatment and location of infected leaves on development of *Gnomonia leptostyla* perithecia during overwintering.

(In numbers)

	Perithecia on 10 leaflets	Perithecia/ cm^2 of leaf surface
Monocultured sites		
On fescue leaves	1069 a*	9.72 a
Under fescue leaves	601 b	4.24 b
On autumn olive leaves	673 b	8.03 a
Under autumn olive leaves	338 c	2.60 b
Companion-planted sites		
On autumn olive leaves	355 c	3.51 b
Under autumn olive leaves	75 d	0.70 b

*Numbers followed by the same letter within columns are not significantly different (P = 0.05) according to Fisher's LSD test

TABLE 4.--Leaflets of potted Pixie tomato plants infected by *Septoria lycopersici* conidiospores by distance from spore source.

(In percent)

Distance from mist blower conidiospore source (meters)	Walnut monoculture plot	Walnut-autumn olive companion plot
3.4	56	70
6.4	73	17
8.8	43	11
11.0	20	6

TABLE 5.--Lesions/leaflet on potted walnut seedlings caused by Gnomonia leptostyla conidiospores by distance from spore source.

Distance from mist blower conidiospore source (meters)	Walnut monoculture plot	Walnut-autumn olive companion plot
2.6	6.76	10.92
4.7	5.59	0.23
6.0	2.73	0.05
8.0	0.71	0.006
10.0	0.25	0
13.0	0.05	0

Effect of Autumn Olive Shading on Eliminating Mycosphaerella-Susceptible Foliage Close to the Ground

Shading by autumn olive foliage induces earlier death of walnut branches close to the ground (table 6). Thus, in companion plantings those branches closest to the source of primary inoculum on the ground are farther away than in monoculture at a similar tree age. Moreover, autumn olive, in its growth as a woody shrub, interposes its own foliar barrier between the primary ground inoculum and the walnut foliage above (table 6).

TABLE 6.--Height to first live branch of 14-year-old black walnut in mixed and pure plantings and to bottom of autumn olive canopy in mixed plantings.

(In meters)

Plot	Companion planting		Monoculture
	Walnut	Autumn olive	Walnut
1	3.35 ± 0.24[a]	2.50 ± 0.15	1.49 ± 0.06
2	3.60 ± 0.24	2.13 ± 0.12	1.46 ± 0.15
3	3.72 ± 0.12	2.03 ± 0.09	1.71 ± 0.12

[a]Standard error of the mean

Table 7 summarizes the interplanting factors that appear to be most responsible for reducing disease severity. Because autumn olive is both an early refoliator in the spring and a late leaf shedder in the fall, its foliage on the tree and after shedding on the ground can interfere at several points in the annual disease cycle. These phenological characteristics of autumn olive may render it useful for companion planting with other hardwood species to control other foliage diseases that have an overwintering ground phase.

TABLE 7.--Autumn olive (AO) interplanting factors that interfere with disease development.

Interplanting factor	Effect on disease	Mechanism
Early emergence of AO foliage	Interferes with dissemination of ascospores	Mechanical barrier
Presence of AO foliage	Earlier death of lower branches in ground zone most favorable for disease development	Shading
	Interferes with spore dissemination	Mechanical barrier
Late shedding of AO foliage	Interferes with perithecial development	Overlayering of AO leaves creates microclimate more favorable to leaf decomposition
	Interferes with dissemination of ascospores	Overlayering of AO leaves creates mechanical barrier

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