Effect of Cherry Leaf Spot on Nursery Black Cherry Seedlings and Potential Benefits from Control

GLEN R. STANOSZ, Forest Pathologist, Pennsylvania Department of Environmental Resources, Bureau of Forestry, Division of Forest Pest Management, Middletown 17057-5021

ABSTRACT

Stanosz, G. R. 1992. Effect of cherry leaf spot on nursery black cherry seedlings and potential benefits from control. Plant Dis. 76:602-604.

A study was conducted to quantify the effect of leaf spot caused by *Blumeriella jaapii* on black cherry seedlings in a nursery. The severity of leaf spot, which had developed from naturally occurring inoculum, was visually estimated on leaves collected from untreated and benomyl-treated subplots in August 1990. Leaves were counted and seedling height, caliper, and area of collected leaves were measured. The number of seedlings with diameters ≥0.40 cm (5/32 in.), the minimum acceptable, was determined before seedlings were lifted in spring 1991. Lower leaves and leaves from untreated subplots were more frequently placed into greater leaf spot severity categories than higher leaves or leaves from treated subplots. Mean leaves per seedling, height, and caliper values were less for untreated seedlings than for treated seedlings, and untreated subplots yielded approximately half as many seedlings of minimum-acceptable diameter as treated subplots. Leaf spot severity was positively correlated with seedling density in untreated subplots. Leaf area tended to be smaller in more dense subplots, and the number of seedlings of minimum-acceptable diameter was negatively correlated with seedling density in both untreated and treated subplots. The control of leaf spot and the regulation of seedling density can increase the efficiency of black cherry seedling production in nurseries.

Additional keywords: *Coccomyces*, *Prunus serotina*

Cherry leaf spot is a serious disease of many cherry and plum species in both orchards and nurseries (4–8). When severe, it results in defoliation and has been associated with lower yields, twig and branch dieback, and reduced winter hardiness of commercial fruit trees. The disease also affects the commercially important forest tree black cherry (*Prunus serotina* Ehrh.). Black cherry leaf spot has been reported to be an important disease of natural regeneration in the Allegheny Plateau section of Pennsylvania (13) and to cause considerable damage to seedlings in forest nurseries (2). The disease is caused by the fungus *Blumeriella jaapii* (Rehm) Arx (syn. *Coccomyces hiemalis* Higgins, *C. lutescens* Higgins, and *C. prunophorae* Higgins) (12) and is widely known as Coccomyces leaf spot.

The cherry leaf spot fungus produces two types of spores by which it is dispersed to infect plants (6). It overwinters in fallen leaves colonized during the previous growing season. In the spring, apothecia on these old leaves release ascospores during moist weather over a period of several weeks (7). These primary windblown spores land on enlarging leaves where the fungus penetrates through stomata on the lower leaf surface (6). Infection occurs during moist periods when leaf surfaces remain wet (3,7). After infection of the current year's leaves, acervuli form on their lower surfaces and produce conidia (6). These secondary spores are rain splashed (7) to other foliage and germinate to enable additional infection. As this cycle is repeated through the summer, epidemics can occur.

Colonized leaves bear purple spots that can enlarge and develop necrotic brown centers. Dead areas of spots sometimes drop out, resulting in "shot-holes." As numerous spots develop, leaves become chlorotic and necrotic and are prematurely shed.

Despite the long association of this disease with black cherry, damage to seedlings and the benefits of control in nurseries have not been quantified. In 1988, the disease was recognized on black cherry seedlings at a nursery operated by the Pennsylvania Bureau of Forestry. No measures to control leaf spot were practiced routinely, and its effect on seedlings, produced as 1-0 stock (i.e., grown 1 yr in the seed bed, then lifted and sold) was unclear. Therefore, a study was designed to determine the impact of leaf spot on black cherry seedlings and the potential benefit from management of this disease in the nursery.

Present address of author: Department of Plant Pathology, University of Wisconsin-Madison, 1630 Linden Drive, Madison 53706.

Accepted for publication 16 January 1992 (submitted for electronic processing).

MATERIALS AND METHODS

This investigation was conducted at Penn Nursery located in the central ridge and valley region of Pennsylvania. The soil was a stony clay loam with a pH of approximately 5.4 in the study area. Beds prepared in late summer 1989 were hand-broadcast with pit-stratified cherry seed in late November. The targeted germinable seed density was 129 per square meter (12 per square foot). Beds then were mulched with approximately 1.27 cm (0.5 in.) of a 3:1 sawdust/sand mixture. Before bed preparation, 10-20-20 N-P-K fertilizer was incorporated at a rate of 279 kg/ha (250 lb/acre). Additional fertilizers applied during the growing season included 46-0-0 at a rate of 62 kg/ha (55 lb/acre) three times, alternating with 10-6-4 at a rate of 279 kg/ha (250 lb/acre) two times. The post-emergent grass-control herbicide sethoxydim (Poast 1.5 E) was applied two times during the 1990 growing season at a rate of 0.21 kg/ha (0.19 lb/acre). Overhead irrigation was provided as needed.

Plots were installed soon after seedling emergence in 1990. Each plot consisted of two subplots (1.22 m [4 ft] long) separated by a buffer (0.61 m [2 ft] long) in nursery beds that were 1.22 m (4 ft) wide. Plots were replicated four times in each of three blocks. Leaf spot was allowed to develop, from naturally occurring inoculum, in one subplot of each plot. The systemic fungicide benomyl (Benlate) was applied to the other. Seedlings in the treated subplots were sprayed to drip with 0.72 g of benomyl per liter of water (0.005 lb/gal). The treatment was applied seven times at 11- to 19-day intervals from 20 May to 12 August 1990 with a hand-pump garden sprayer.

The black cherry beds in which study plots were located were initially untreated. However, by midsummer, the severity of disease in these beds (compared with treated subplots) indicated a need for treatment. Therefore, except for the study plots, the entire beds were sprayed with benomyl on 9 and 25 July 1990.

Seedling measurements, leaf counts, and leaf collections were made on 9 August 1990. Seedling height (to the nearest centimeter) and diameter near the soil line (to the nearest 0.1 mm) were measured, and leaves were counted on 10 randomly selected seedlings in both treated and control sections of each plot. Randomly selected leaves (10 from within 30 cm of the soil and 10 from above that height) from each subplot were pressed and later measured (to the nearest 0.1 cm^2) with a LI-COR LI-3000 portable area meter (LI-COR, Inc., Lincoln, NE). The amount of each pressed leaf's surface affected by leaf spots or associated chlorosis and necrosis was estimated visually as 0–3, >3–10, >10–25, >25–50, and >50%.

Before lifting in spring 1991, inventory was conducted in the central portion (0.61 m [2 ft] long [by the width of the bed]) of each sprayed or untreated subplot. Seedlings within that area were counted. These seedlings also were measured near the soil line with a notched gauge that indicated a minimum acceptable diameter (≥0.40 cm [5/32 in.]).

Data were analyzed using Minitab data analysis software release 5.1 (Minitab, Inc., State College, PA). A chi-square test for independence (9) was used to compare frequency distributions of the numbers of leaves assigned to the different leaf spot sevērity categories. Two-way analyses of variance were used to analyze the effects of treatment and block on seedling responses (height, number of leaves, individual leaf area, and diameter) and on productivity (number of seedlings per unit area and the percentage of seedlings of acceptable diameter). The relationship between the number of seedlings per unit area and the number of leaves in the two highest leaf spot severity categories or the percentage of seedlings of acceptable diameter were analyzed using linear regression.

RESULTS

Although leaf spot was not detected in May when plots were installed, differences were observed on the leaves collected in August (Table 1). Chi-square analyses revealed a lack of independence between the numbers of leaves assigned to leaf spot severity categories and both treatment ($P < 0.001$) and leaf position ($P < 0.001$). Leaves from untreated seedlings were more frequently placed into higher severity categories than leaves from treated seedlings. Leaves collected from within 30 cm of the soil surface, particularly those from untreated seedlings, also were more frequently placed into higher severity categories than leaves collected above that height. Leaf spot severity in the untreated subplots also was related to seedling density. Linear regression analysis revealed a significant ($P < 0.05$, $R^2 = 42.9$) positive relationship between the numbers of seedlings per unit area and the numbers of leaves from those subplots that had been placed into the two highest severity categories (>25–50 and >50%).

Two-way analyses of variance revealed the effect of treatment on the number of leaves per seedling ($P < 0.001$), seedling height ($P < 0.001$), and seedling diameter ($P < 0.001$) determined on 9 August 1990. Untreated seedlings bore, on average, approximately 20–30% as many leaves as treated seedlings (Fig. 1A). Untreated seedlings also tended to be shorter (Fig. 1C) and thinner (Fig. 1D). There was no significant interaction of treatment and block effects for these variables.

The effect of block on the number of seedlings per unit area ($P < 0.01$) and individual leaf area ($P < 0.001$) was indicated by two-way analysis of variance. In block 3, average seedling densities for both sprayed and unsprayed subplots were lower than in blocks 1 and 2, respectively (Fig. 2A). The averages for area of individual leaves collected from block 3 were greater than in either blocks 1 or 2 (Fig. 1B). There were neither significant treatment effects nor significant interaction of treatment and block effects for these variables.

The percentage of seedlings that had attained acceptable diameter before lifting (Fig. 2B) was influenced both by treatment ($P < 0.001$) and block ($P < 0.05$). In all blocks, only 33% of untreated seedlings had diameters ≥0.40 cm (5/32 in.), compared with 63% of treated seedlings. Thus, the average number of seedlings with an acceptable diameter in untreated subplots was 32.72 per square meter (3.04 per square foot) compared with 67.06 per square meter (6.23 per square foot) for treated subplots. Ranges were 17.44–44.56 per square meter (1.62–4.14 per square foot) and 53.93–81.59 per square meter (5.01–7.58 per square foot), respectively. The percentage of seedlings with an acceptable diameter was highest, for both treated and untreated subplots, in block 3.

Table 1. Numbers[a] of black cherry leaves, from benomyl-treated and untreated nursery subplots, categorized by severity of leaf spot

		Leaf spot severity category[d]				
Leaf position[b]	**Treatment**[c]	**0–3%**	**>3–10%**	**>10–25%**	**>25–50%**	**>50%**
Upper	Benomyl	113[e]	5	2	0	0
	Untreated	72	22	17	6	3
Lower	Benomyl	90	24	2	1	3
	Untreated	5	5	15	28	67

[a] Values reported are numbers of seedlings, out of a possible 120 (10 from each leaf position per subplot, four subplots per treatment in each of three blocks), that fall into the given category.
[b] Half of the leaves from each plot were collected within 30 cm of the soil surface; the remainder were collected above that height.
[c] Subplots were sprayed to drip with benomyl seven times at 11- to 19-day intervals from 20 May to 12 August 1990. Leaves were collected on 9 August 1990.
[d] The percentage of the area of each leaf affected by leaf spots or associated chlorosis or necrosis was visually estimated.
[e] Each distribution (entire row) is significantly different at $P < 0.05$ from others as determined by chi-square test of independence.

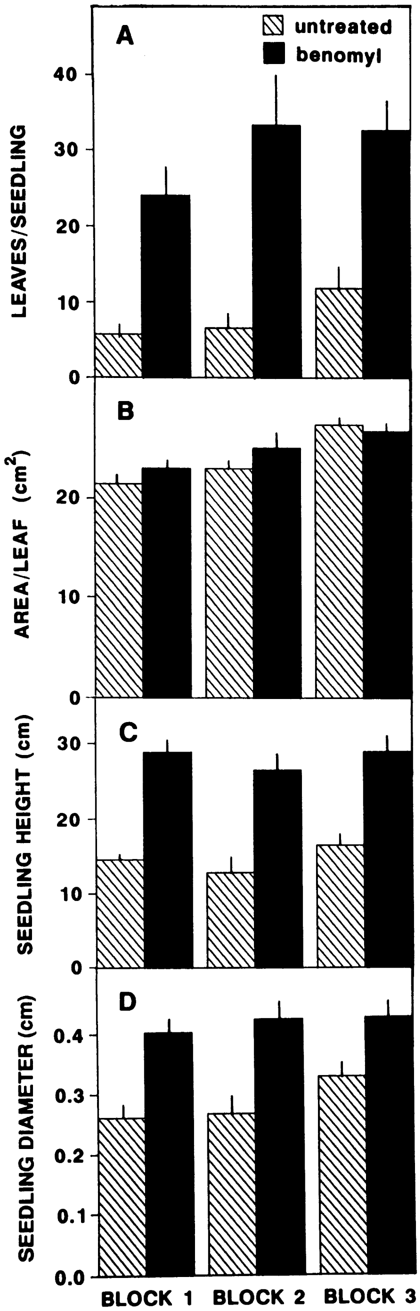

Fig. 1. Responses of black cherry seedlings in nursery subplots untreated or treated with benomyl to control leaf spot. Treated seedlings were sprayed to drip seven times at 11- to 19-day intervals from 20 May to 12 August 1990. Counts and measurements (10 seedlings per subplot) and leaf collections (20 leaves per subplot) were made 9 August. Bars represent means for four subplots. Vertical lines represent standard error.

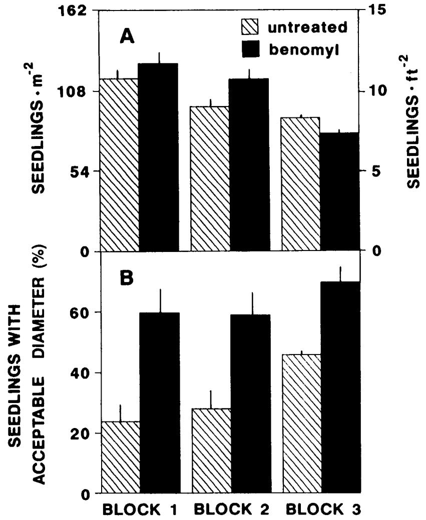

Fig. 2. Productivity of black cherry nursery subplots untreated or treated with benomyl to control leaf spot. Treated seedlings were sprayed to drip seven times at 11- to 19-day intervals from 20 May to 12 August 1990. Acceptable caliper was ≥0.40 cm (5/32 in.). Data were collected before lifting in 1991. Bars represent means for four subplots. Vertical lines represent standard error.

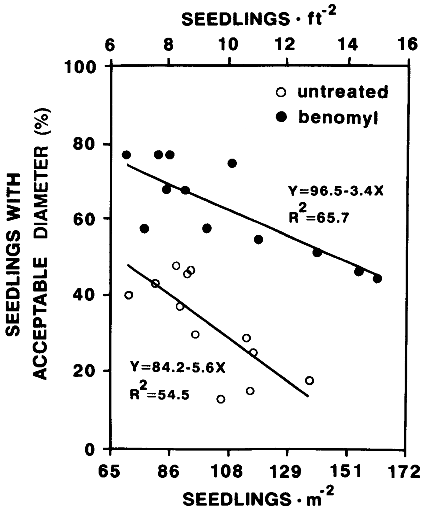

Fig. 3. Numbers of black cherry seedlings with caliper ≥0.40 cm (5/32 in.) in nursery subplots of different densities that were untreated or treated with benomyl to control leaf spot. Treated seedlings were sprayed to drip seven times at 11- to 19-day intervals from 20 May to 12 August 1990. Data were collected before lifting in 1991. Each point represents data from one of four subplots per treatment in each of three blocks.

Linear regression analyses revealed that the percentage of seedlings with an acceptable diameter increased as seedling density decreased (Fig. 3). This relationship was significant for both treated ($P < 0.005$) and untreated ($P < 0.01$) subplots but was more pronounced in the latter.

DISCUSSION

The deleterious effects of leaf spot observed in this study are consistent with the reports of damage to black cherry (2) and other *Prunus* species (5) in nurseries. Results also confirm the effects of seedling height and density on disease severity indicated from observations of natural black cherry regeneration in forest stands (10,11). The interrelationships among factors that affect both leaf spot severity and seedling growth indicate the potential for both cultural manipulation and application of direct control measures to maximize productivity of black cherry nursery beds.

The development of severe leaf spot may be suppressed or delayed by removing the source of initial inoculum, fallen leaves colonized the previous growing season. The beneficial effect of sanitation in a cherry orchard has been demonstrated (7). Sanitation is inherent in 1-0 seedling production in which old beds are plowed and new seedbeds are formed each year. During 2-0 production practiced in some nurseries, however, colonized leaves that accumulate on the beds the first year will provide abundant inoculum to infect seedlings the second year. Therefore, the production of seedlings in a single year would be preferable and may justify an aggressive fertilization program, weed control, and irrigation to allow attainment of acceptable size. Initial inoculum also might be avoided by separating nurseries from black cherry seed orchards and eliminating hosts from windbreaks and adjacent areas.

The association of high disease severity with lower leaves may result from a number of factors. Black cherry seedlings continue to grow taller and produce new leaves throughout the growing season. Lower leaves can be infected earlier and can be colonized for a longer period of time than upper leaves. Leaves produced later in the growing season also might have inherent resistance based on morphology or nutrition, etc. Upper leaves probably avoid much secondary inoculum, conidia carried downward by rain and irrigation water. The microclimate of lower leaves might be more moist and, therefore, more conducive to infection. High disease severity on lower leaves suggests the importance of protecting seedlings from disease early in the growing season, so that leaf retention and subsequent height and diameter growth will occur.

Favorable seedling density is important to avoid severe disease and to provide conditions that allow adequate seedling growth (1). Densely packed seedling leaves might have a microclimate favorable to infection, and conidia might easily be splashed or dripped from leaf to leaf. Less densely grown seedlings also have less competition for available sunlight, water, nutrients, and space. Less dense stands of seedlings also may receive improved coverage by fungicidal sprays.

Subsequent experience at Penn Nursery indicates the practicality and benefits from these suggestions for management of leaf spot on black cherry. As few as two applications of benomyl can be made, the first soon after detection of leaf spot in June and the second before mid-July. These sprays are used in conjunction with seedling densities of 65–86 per square meter (6–8 per square foot). Seedlings develop and maintain adequate foliage, and a high proportion achieve acceptable diameter.

ACKNOWLEDGMENTS

I thank the nursery staff, especially Amy Griffith and Alexander Day, for cooperation in this study; Alan Sior, James Unger, and Joanne Fails for help during inventory; Don Davis and Doug Rouse for presubmission review; Steve Vicen for help with graphics; and Kathryn Kuharic and Veronica King for clerical assistance.

LITERATURE CITED

1. Cordell, C. E., Kelley, W. D., and Smith, R. S. 1989. Integrated nursery pest management. Pages 5-11 in: Forest Nursery Pests. U.S. Dep. Agric. For. Serv. Agric. Handb. 680. 184 pp.
2. Davis, W. C., Wright, E., and Hartley, C. 1942. Diseases of forest-tree nursery stock. Fed. Sec. Agency Civ. Conserv. Corps For. Publ. 9. 79 pp.
3. Eisensmith, S. P., and Jones, A. L. 1981. A model for detecting infection periods of *Coccomyces hiemalis* on sour cherry. Phytopathology 71:728-732.
4. Heald, F. D. 1933. Manual of Plant Diseases. McGraw-Hill, New York. 953 pp.
5. Hesler, L. R., and Whetzel, H. H. 1917. Manual of Fruit Diseases. MacMillan, New York. 462 pp.
6. Higgins, B. B. 1914. Contribution to the life history and physiology of *Cylindrosporium* on stone fruits. Am. J. Bot. 1:145-173.
7. Keitt, G. W., Blodgett, E. C., Wilson, E. E., and Magie, R. O. 1937. The epidemiology and control of cherry leafspot. Wis. Agric. Exp. Stn. Res. Bull. 132. 117 pp.
8. Sjulin, T. M., Jones, A. L., and Andersen, R. L. 1989. Expression of partial resistance to cherry leaf spot in cultivars of sweet, sour, duke, and European ground cherry. Plant Dis. 73:56-61.
9. Sokal, R., and Rohlf, F. 1973. Introduction to Biostatistics. Freeman, San Francisco. 368 pp.
10. Stanosz, G. R. 1990. Relationships among forest litter burning, seedling density, and black cherry leafspot severity in northern Pennsylvania. (Abstr.) Phytopathology 80:991.
11. Stanosz, G. R., and Auchmoody, L. 1989. Relationship of seedling height and dolomitic lime application to black cherry leafspot severity in northern Pennsylvania. (Abstr.) Phytopathology 79:1143-1144.
12. von Arx, J. A. 1961. Über *Cylindrosporium padi*. Phytopathol. Z. 42:161-165.
13. Zabel, R. A., Silverborg, S. B., and Fowler, M. E. 1958. A survey of forest tree diseases in the Northeast—1957. U. S. Dep. Agric. For. Serv. For. Exp. Stn. Pap. NE-110. 30 pp.