Susceptibility of Selected Juniper Cultivars to Cedar-Apple Rust, Kabatina Tip Blight, Cercospora Needle Blight and Botryosphaeria Canker[1]

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Abstract

The susceptibility of 39 juniper (*Juniperus* L.) cultivars to cedar-apple rust (*Gymnosporangium juniperi-virginianae* Schwein.), Kabatina tip blight (*Kabatina juniperi* R. Schneider & Arx), Cercospora needle blight (*Cercospora sequoiae* Ellis & Everh. var. *juniperi* Ellis & Everh.), and Botryosphaeria canker (*Botryosphaeria stevensii* Shoemaker) was studied in field plantings located in Wichita and Manhattan, KS. Cultivars of *J. scopulorum* Sarg. showed variable susceptibility to cedar-apple rust and most were moderately to highly susceptible to Kabatina tip blight and Cercospora needle blight. Many were also severely damaged by Botryosphaeria canker. Most *J. virginiana* L. cultivars were susceptible to cedar-apple rust but were more resistant to other disease problems than *J. scopulorum*. Cultivars of *J. chinensis* were highly resistant to all four diseases observed in the plantings. Conidia of *B. stevensii* were primarily collected in spore traps in late May and June, suggesting this is a major period for fungal infection.

Index words: *Gymnosporangium juniperi-virginianae*, *Cercospora sequoiae* var. *juniperi*, *Kabatina juniperi*, *Botryosphaeria stevensii*, diseases, resistance.

Species used in this study: Chinese juniper (*Juniperus chinensis* L.); Rocky Mountain juniper (*Juniperus scopulorum* Sarg.); eastern redcedar (*Juniperus virginiana* L.).

Significance to the Nursery Industry

This study provides information on the resistance of 39 cultivars of eastern redcedar, Chinese juniper and Rocky Mountain juniper to cedar-apple rust, Kabatina tip blight, Cercospora needle blight and Botryosphaeria canker. Cultivars of Chinese juniper were resistant to all four diseases. Most eastern redcedar cultivars were susceptible to cedar-apple rust but moderately to highly resistant to the other diseases. In contrast, most Rocky Mountain juniper cultivars were moderately to highly susceptible to Kabatina and Cercospora blights and Botryosphaeria canker and probably should not be used in low maintenance landscape plantings. Nursery managers should avoid heavy pruning or shearing of junipers susceptible to Botryosphaeria canker in late May or June (peak spore release period) to reduce chances of infection.

Introduction

Junipers are a common component of landscape plantings throughout North America because of their adaptation to a wide variety of geographic and microclimatic conditions. Several diseases may adversely affect the appearance and health of these trees and shrubs. Common diseases include cedar-apple rust (*Gymnosporangium juniperi-virginianae* Schwein.), Phomopsis tip blight (*Phomopsis juniperovora* Hahn), Cercospora needle blight (*Cercospora sequoiae* Ellis & Everh. var. *juniperi* Ellis & Everh.), Kabatina tip blight (*Kabatina juniperi* R. Schneider & Arx) and more recently, Botryosphaeria canker (*Botryosphaeria stevensii* Shoemaker). Although some of these diseases, such as Cercospora needle blight and Phomopsis tip blight, can be controlled with fungicides (7), they may be problematic in low maintenance landscape plantings. Selection and use of juniper cultivars with resistance to one or more diseases would be a more desirable approach to control. Some juniper species and cultivars with resistance to one or more diseases have been identified (2, 3, 4, 5, 6, 10), but ratings of many widely used cultivars have not been determined. In this study, the resistance of *J. chinensis*, *J. scopulorum* and *J. virginiana* cultivars to cedar-apple rust, Kabatina tip blight, Cercospora needle blight, and Botryosphaeria canker was evaluated.

Infection periods for Cercospora needle blight, Phomopsis tip blight, and cedar apple rust are known (7, 8) and have been used for timing of fungicide applications and in developing other controls. In contrast, relatively little is known about conditions favoring infection by *B. stevensii*. Wounding is apparently necessary for infection (12), but periods of spore production and infection have not been determined. We studied seasonal spore release of *B. stevensii* from diseased junipers to identify infection periods.

Materials and Methods

In 1981 and 1982, one-year-old grafts and rooted cuttings of 39 cultivars of *Juniperus scopulorum*, *J. chinensis*, and *J. virginiana* (Table 1) were obtained from wholesale nurseries. These cultivars are still widely used in landscape plantings. Plants were potted in 7.6 liter (2 gal) plastic containers in a soil:sand medium (1:1 by vol) and grown for 3–4 years before outplanting. In 1985, 3–5 plants of each cultivar were planted at the Horticulture Research Center in Wichita, KS, and at the Rocky Ford Experimental Field in Manhattan, KS. Trees were planted in 4–5 rows approximately 52 m (170.5 ft) in length and 4–5 m (13.1–16.4 ft) apart at each location. Tree spacing within rows was 2 m

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Table 1. Disease ratings of various *Juniperus* cultivars to cedar-apple rust, Kabatina tip blight, Cercospora needle blight and Botryosphaeria canker.

	Cedar-apple rust[x]	Kabatina tip blight	Cercospora needle blight	Botryo-sphaeria canker[y]
J. chinensis				
Ames	0.0a	0.0a	0.0a	none
Blue Point	0.0a	3.0h	0.0a	none
Columnaris hetzii	0.0a	0.0a	0.0a	none
Keteleeri	0.0a	0.0a	0.0a	none
Maneyii	0.0a	0.0a	0.0a	none
Mountbatten	0.0a	0.0a	0.0a	none
Perfecta	0.0a	0.0a	0.0a	none
Robusta Green	0.0a	0.0a	0.0a	none
Spartan	0.2a	1.7cde	0.0a	none
Wintergreen	0.0a	0.0a	0.0a	none
J. scopulorum				
Blue Haven	1.5cde	3.0h	3.5de	++
Cologreen	2.1df	1.7cde	3.0de	++
Dewdrop	1.7defg	2.0def	2.3bcde	+
Gray Gleam	1.6cdefg	2.4efg	0.3ab	none
McFarland	1.7defg	1.0bc	4.0e	++
Medora	0.0a	2.0def	1.5abc	++
Moffettii	2.0efg	2.7fgh	2.3bcde	none
Moonglow	0.0a	2.8gh	2.0abcd	++
Pathfinder	1.2bcd	2.2ef	2.5cde	none
Platinum	0.9abcd	1.0bc	2.3bcde	none
Silver Globe	1.1bcd	1.3bcd	0.7abc	none
Skyrocket	1.3bcd	3.7i	2.5cde	++
Sparkling Skyrocket	1.8defg	3.3hi	3.0de	++
Sutherland	4.6j	1.0bc	2.3bcde	+
Table Top	0.7abc	1.7cde	2.0abcd	none
Welchii	0.7abc	2.3efg	1.7abcd	+
Wichita Blue	0.7abc	3.2hi	3.5de	++
J. virginiana				
Admiral	0.7abc[z]	1.3bcd	0.0a	none
Blue Mountain	0.0a	0.1a	0.3ab	none
Burkii	3.0	1.0bc	0.0a	none
Canaertii	4.6i	0.8b	0.0a	none
Emerald Sentinel	2.0defg	1.0bc	0.3ab	none
Grey Owl	0.0a	0.1a	0.0a	none
Henryii	2.6gh	1.0bc	0.3ab	none
Hillii Dundee	3.3hi	1.2bc	0.0a	none
Hillspire	0.0a	1.0bc	0.3ab	none
Manhattan Blue	4.0i	1.2bc	0.0a	none
Oxford	1.0bcd	1.0b	0.0a	none
Wren	2.0efg	0.8b	0.0a	none

[z]Means not followed by the same letter are significantly different (P = 0.05) by a protected, pairwise comparison of least square means. Means for rust and Kabatina tip blight are based on ratings taken from 1993–1995 at two locations. Means for Cercospora needle blight based on ratings in 1995 at both locations.

[y]Natural infection and development of Botryosphaeria canker. A rating of none = canker development not observed, + = canker development observed on branch of at least one tree of the cultivar at either Manhattan or Wichita, ++ = multiple cankers or extensive branch dieback resulting from infection on one or more trees of the cultivar.

[x]Disease severity for rust, Kabatina and Cercospora was rated on a 0–5 scale where 0 = no disease; 1 = light infection with 1–19% of the branches with symptoms (tip dieback, rust galls or diseased needles); 2 = moderate infection with 20–39% of branches with symptoms; 3 = moderate to heavy infection with 40–59% of branches with symptoms; 4 = heavy infection with 60–79% branches with symptoms and 5 = severe infection with >80% of branches showing symptoms or tree exhibiting significant dieback or decline.

(6.6 ft). Individual juniper cultivars were randomly assigned positions within each planting, but replicate trees of each cultivar were planted together within the row (i.e., not randomly blocked). To increase the severity of cedar-apple rust, a single cedar-apple rust-susceptible flowering crabapple (*Malus* sp.) was planted near the center of each juniper planting. After planting, junipers were fertilized with 112 kg N per ha. Junipers received little maintenance after establishment. Weeds in rows and around the base of trees were controlled yearly with pre-emergence herbicides or by mowing. Junipers were not pruned, irrigated or fertilized after the first year.

Juniper cultivars were rated each year following field establishment for natural infection by *K. juniperi*, *C. sequoiae* var. *juniperi*, and *G. juniperi-virginianae*. Disease severity was rated on a 0–5 scale where 0 = no disease; 1= light infection with 1–19% of the branches with symptoms (tip dieback, rust galls or diseased needles); 2 = moderate infection with 20–39% of branches with symptoms; 3 = moderate to heavy infection with 40–59% of branches with symptoms; 4 = heavy infection with 60–79% branches with symptoms; and 5 = severe infection with >80% of branches showing symptoms or tree exhibiting significant dieback or decline. Disease ratings were analyzed by a mixed analysis procedure (9) in which location (Wichita, Manhattan) was treated as a block (replicate) and year (1993, 1994, 1995) was treated as a strip plot. Ratings of the 3–5 replicates of each cultivar at each location were averaged prior to analysis because they were not true replicates. Statistical separation of disease severity ratings among cultivars was determined by protected, pairwise comparisons of least square means (9).

The development of cankers following artificial inoculations with *B. stevensii* was studied at the Manhattan location only. On August 19, 1987, a branch (5–15 mm diameter) on three trees of each cultivar was inoculated by inserting an agar block containing mycelium of the fungus into a small wound made by a scalpel in the manner described by Tisserat et. al. (12). Sterile agar was inserted into three additional branches to serve as controls. Canker development was determined by periodically measuring the length of discolored bark at the inoculation site. The experiment was repeated in May 1989.

Seasonal release of conidia (spores) of *B. stevensii* was studied in 1987 and 1988 by placing a Kramer-Collins spore trap (Manhattan KS) approximately 1 m (3.28 ft) from a diseased *J. scopulorum* tree located in a Manhattan, KS, windbreak. Briefly, the spores were collected by drawing air through a small orifice on a closed container attached to a vacuum pump. Spores in the air were impacted on the surface of double-sided transparent tape (Scotch Brand, 3M Center, Box 33053, St. Paul, MN) thinly coated with petroleum jelly. The tape was wrapped around the surface of a drum attached to a clock mechanism that made one revolution each week. The spore collector was run continuously from early March through mid-September in both years. Each week the tape was removed from the surface of the drum and cut into sections equal to a 24-hr sampling period. Tape sections were mounted on a microscope slide and all conidia of *B. stevensii* were counted in two randomly selected passes across the length of tape at 400× magnification. A relative spore count for each week was determined by summing the number of spores recorded for each 24-hr section of tape.

Results and Discussion

Natural development of cedar-apple rust, Kabatina tip blight and Cercospora needle blight was light and inconsistent on junipers during the first six years of the study then increased as trees matured and filled gaps within rows. This created more favorable microclimatic conditions for fungal infection. There was no significant year (1993–1995) × cultivar interaction for Kabatina tip blight and cedar-apple rust. Ratings for these diseases remained relatively consistent during the last three years of the study. There was a significant year × cultivar interaction for Cercospora needle blight because several *J. scopulorum* cultivars did not develop symptoms until 1995. In order to reflect the potential for damage during environmental and/or cultural conditions optimal for disease development, only disease ratings from 1995 are presented for Cercospora needle blight.

Juniper species and cultivars exhibited differences in susceptibility to cedar-apple rust, Kabatina tip blight and Cercospora needle blight (Table 1). All *J. chinensis* cultivars were highly resistant to all three diseases at both locations. Most cultivars of *J. virginiana* were very susceptible to cedar-apple rust although 'Admiral', 'Blue Mountain', 'Hillspire' and 'Oxford' showed little or no rust development during the study. Kabatina tip blight and Cercospora tip blight development was low or absent on all *J. virginiana* cultivars. In contrast, most cultivars of *J. scopulorum* had unacceptable levels (ratings >2.0) of both Cercospora and Kabatina blights. Many also had low to moderate susceptibility to cedar-apple rust.

Cedar-quince [*G. clavipes* (Cooke & Peck) Cooke & Peck in Peck] and cedar-hawthorn [*J. globosum* (Farl.) Farl.] rusts were not found on any cultivars during the study. This was probably the result of a lack of inoculum from alternate hosts in the vicinity of the plantings. Further studies are needed to clarify whether there is a correlation in resistance ratings among various rust diseases on junipers.

Kabatina tip blight was responsible for all of the branch tip dieback in both plantings. Interestingly, Phomopsis tip blight was not detected on any trees during the study. Phomopsis tip blight is often a serious problem of junipers during nursery production (2, 7) and is generally assumed to be the primary cause of branch tip dieback of *J. horizontalis* (10). It is often erroneously blamed for branch tip dieback occurring on other juniper species. Symptoms of Phomopsis tip blight and Kabatina tip blight are similar in that both cause dieback of the terminal 2.5–7.6 cm (4–6 in) of shoot growth. However, *K. juniperi* infects shoots in fall (6) and results in shoot death in early spring, whereas *P. juniperovora* infects succulent shoot growth throughout the summer months. Our results suggest that Kabatina tip blight is a more common cause of juniper shoot dieback of *J. scopulorum* and *J. virginiana*, at least in the Great Plains region.

All cultivars of *J. chinensis*, *J. scopulorum*, and *J. virginiana* inoculated in 1987 and 1989 with *B. stevensii* developed sunken, resinous cankers within 6 months. Cankers tended to increase in length more rapidly on *J. scopulorum* cultivars (data not shown), but quantitative assessment was difficult because many cankers rapidly girdled small diameter twigs. Furthermore, cankers did not progress from small twigs into larger branches [> 3 cm dia (1.2 in)] or into the main trunk on any of the inoculated trees. There was no natural canker development on *J. chinensis* or *J. virginiana* cultivars at either site. Conversely, many *J. scopulorum* cultivars in both Manhattan and Wichita plantings developed naturally occurring, girdling trunk and branch cankers (Table 1) and suffered significant branch dieback. These results are consistent with our observations and previous reports (12) that Botryosphaeria canker is a destructive disease of *J. scopulorum* and is a limiting factor in the use of this species in Kansas windbreaks and landscape plantings. Branch cankers have occasionally been observed on *J. sabina* L. and *J. virginiana* in landscape plantings in Kansas. However, these species appear to be less susceptible than *J. scopulorum*. Botryosphaeria canker has been reported in Iowa (1) and Pennsylvania (11) and is probably distributed throughout the United States.

Conidia of *B. stevensii* were collected from late May through September in 1987 and from mid-May through July in 1988 (Fig. 1). A majority of conidia were deposited during a 6-wk period in May and June. Spore deposition usually occurred on days with rain in excess of 0.3 cm (0.1 in) (data not shown). The abundance of conidia, frequent rains, and temperatures favorable for fungal infection (12) suggest that new infections occur in May and June. Since *B. stevensii*

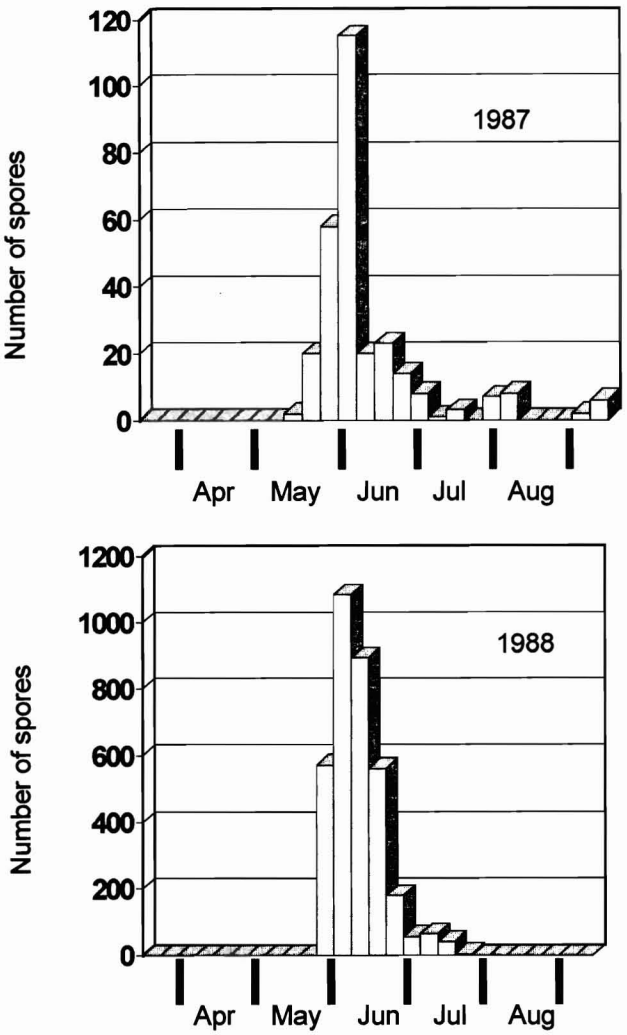

Fig. 1. Seasonal liberation of *Botryosphaeria stevensii* conidia. Each bar represents the relative number of spores collected during a one week sampling period.

apparently requires wounding for infection (12), do not prune or shear susceptible junipers during this period.

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