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Susceptibility of Southern Blueberry Cultivars to *Botrytis* Blossom Blight

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Abstract

The susceptibility of blueberry flowers at various developmental stages was evaluated by inoculating potted blueberry bushes of the rabbiteye cultivars, Climax, Premier and Tifblue, and the southern highbush cultivars, Magnolia and Jubilee, during bloom with a conidial suspension of *Botrytis cinerea*. Inoculated plants were then incubated in a dew chamber for two days at 20°C and 100% RH. Flower stage was rated at the beginning of the study and two weeks after inoculation. *Botrytis* disease symptoms were scored two weeks after inoculation on a visual scale of 0 to 7. Susceptibility to *Botrytis* blossom blight was greatest on more developed flowers. Buds inoculated at stage 2 through stage 3 (prebloom) developed few disease symptoms, while flowers inoculated at stages 5 to 7 (full bloom) developed more severe symptoms. 'Magnolia,' 'Premier,' and 'Tifblue' flowers at stage 6 were very susceptible. When averaged over the more susceptible flower stages (5, 6 and 7), 'Jubilee' and 'Premier' had the lowest disease severity scores. 'Tifblue' had higher disease scores than 'Magnolia' and 'Climax.' The two southern highbush cultivars did not differ as a group from the three rabbiteye cultivars in their susceptibility to *Botrytis* blossom blight. Since susceptibility of blueberry flowers is greatest at or near full bloom, fungicide applications for *Botrytis* blight control of southern blueberries should begin at flower stage 4 and continue though stage 6.

Southern highbush blueberry cultivars (hybrids between northern highbush blueberry (*V. corymbosum* L.) and various native southern *Vaccinium* spp.) are being planted throughout the southeastern United States. Since many of the newer southern highbush cultivars flower later but ripen earlier than rabbiteye (*Vaccinium ashei* Reade) cultivars (5), they are less likely to be injured by the late spring freezes which have caused major crop losses in the rabbiteye industry. Little is known about the susceptibility of the southern highbush cultivars to diseases (6, 8, 10, 11).

Botrytis blossom blight (caused by the fungus *Botrytis cinerea* Pers.:Fr.) occasionally causes severe crop loss of rabbiteye blueberries, but usually is unimportant on highbush blueberry (2, 3, 4, 9, 13). The fungus attacks blossoms, tender green twigs, and leaves in early spring causing symptoms on rabbiteye blueberry that are often mistaken for freeze injury. Infected flowers and twigs quickly turn brown or black and die. The fungus pro-

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duces abundant gray masses of conidia that can quickly spread throughout the field. High humidity (>95%) and cool temperatures (15-20°C) are ideal for *Botrytis* infection. Often the fungus will advance from infected flower clusters into the stem, girdling it and killing all flowers above the infection point. The same fungus causes *Botrytis* fruit rot, but losses due to fruit rot in the southeastern U. S. on rabbiteye blueberry are minimal. *Botrytis* sp. is also an aggressive saprophyte which can invade tissue injured during spring freezes (1).

Previously (11), the susceptibility of blueberry flowers at each developmental stage (12) was determined for the rabbiteye cultivars, Climax, Premier and Tifblue, and the southern highbush cultivar, Gulfcoast. 'Tifblue' and 'Gulfcoast' had more severe blossom blight scores than 'Premier' and 'Climax' when averaged over all flower stages. Susceptibility increased at later flower stages. Buds inoculated at stage 1 through stage 3 (prebloom) developed little *Botrytis* blossom blight, while flowers inoculated at stages 5 to 7 (full bloom) developed more severe symptoms. 'Tifblue' flowers at or near full bloom (stages 5, 6 and 7) at the time of inoculation with *B. cinerea* were killed within four weeks. Flowers of 'Climax' and 'Premier' were more susceptible near full bloom than at earlier flower stages; however, their flowers were not usually killed. Flower stage at inoculation did not affect the susceptibility of the southern highbush cultivar Gulfcoast. The objective of this study was to compare the relative susceptibility of flowers of rabbiteye and southern highbush blueberry cultivars at several developmental stages to *Botrytis* blossom blight.

Materials and Methods

Plant maintenance. Two- and three-year-old plants of the southern highbush cultivars Jubliee and Magnolia, and rabbiteye cultivars Climax, Premier and Tifblue, were grown in 3 L pots containing a mixture of coarsely ground pine bark and sand (1:1, vol:vol). Plants were spaced 30 cm apart on black fabric mulch placed on the ground, watered as needed via overhead irrigation, and subjected to naturally occurring temperature and rain conditions until mid-February. Since an earlier study (11) had shown that flowers are more susceptible at or near full bloom, six to eight plants of each cultivar with the majority of their flowers near full bloom were selected for uniformity of size and flower bud development. Half the plants were randomly assigned to be inoculated with *B. cinerea*. The remaining plants served as uninoculated controls. All flower buds (up to 50) on each plant were tagged and rated for flower stage development on a scale of 1 (dormant bud) to 7 (flower whose corolla

Table 1. Average blossom blight severity score of five blueberry cultivars two weeks after inoculation with *Botrytis cinerea*.

	Disease severity score[1]						
Flower Stage[2]	Magnolia	Premier	Climax	Tifblue	Jubilee	lsd[3]	N[4]
2	0.97	*[5]	*	*	*	ns	64
3	2.00	1.53	*	*	*	ns	28
4	3.58	2.26	*	*	*	ns	43
5	4.38	2.00	1.50	3.80	*	1.51	93
6	5.09	4.67	2.67	4.30	1.80	1.97	118
7	*	*	3.05	5.00	1.10	3.44	65
lsd[6]	2.48	2.68	1.24	ns	ns		
N[4]	157	102	79	42	31		

[1]Disease severity rated on a scale of 0 = no visible symptoms to 7 = flower cluster dead with lesion extending into stem.
[2]Flower stage at inoculation rated on scale of 1 to 7 (12).
[3]Least significant difference (P = 0.05) within flower stage (row).
[4]Number of flowers observed.
[5]No flowers at this stage at inoculation.
[6]Least significant difference (P = 0.05) within cultivar (column).

has dropped) (12). Any young berries that developed as the study progressed were given a flower stage rating of 8. Subsequent development of each bud was rated two weeks after inoculation.

Inoculum production and inoculation technique. *B. cinerea* was isolated from a 'Tifblue' blueberry plant grown in south Mississippi by harvesting conidia with a sterile needle from diseased flowers and spreading conidia over the surface of potato dextrose agar (PDA) acidified with 1 ml of 4% lactic acid per liter. Fungal inoculum was prepared from 10 to 16-day-old cultures grown on PDA in the laboratory at approximately 22°C. A conidial suspension was prepared by flooding plates with sterilized, distilled water and dislodging conidia by stirring with a glass rod. Conidia were counted using a hemacytometer and the spore concentration adjusted to 2.5 X 10^5 conidia ml^{-1} unless noted otherwise. Tween 20 (0.04%) was added to the suspension prior to inoculation.

Buds and flowers on each plant were inoculated by using a hand pump sprayer to mist each plant with the conidial suspension to the point of run-off. Control plants were sprayed with sterile distilled water containing Tween 20 (0.04%). Plants were then incubated for two days in a dark dew chamber (Percival I-60DL, Boone, Iowa) at 20°C and 100% RH. For the remainder of the study, plants were maintained in an unheated shade house (60% shade). The plants were placed on benches two meters from a mist system (5 sec mist every 5 min for 16 h a day) which resulted in a high relative humidity in the area without misting the plants.

Disease assessment and data analysis. Two weeks after inoculation, flowers on each plant were rated for disease development. *Botrytis* symptoms were scored on a visual scale of 0 = no visible symptoms; 1 = small red spots on corolla; 2 = one to four watersoaked lesions on corollas of flower cluster; 3 = corollas of all flowers in a cluster brown, ovaries green and undamaged; 4 = corollas brown and ovaries of young developing berries damaged; 5 = all flowers or berries within a cluster dead; 6 = all flowers or berries within a cluster dead and covered with spores; 7 = lesion extends from dead cluster into stem (11). Periodically lesions from inoculated flowers were plated onto acidified PDA to confirm the presence of the pathogen. The study was designed as a randomized complete block with two factors (flower stage and cultivar) and four replications. Individual flowers were the experimen-

Table 2. Average blossom blight severity score and flower stage rating two weeks after treatment of five blueberry cultivars inoculated with *Botrytis cinerea* and not inoculated.

		Inoculated			Not inoculated		
Main effect	Treatment	N[1]	Disease score[2]	Flower stage[3]	N	Disease score	Flower stage
Cultivar	Jubilee	31	1.32 c[4]	7.10 a	29	1.34 a	7.14 a
	Premier	50	2.12 bc	6.72 b	56	0.43 b	6.95 b
	Climax	79	2.62 b	7.03 a	62	1.76 a	6.89 bc
	Magnolia	77	4.95 a	6.27 c	65	1.55 a	6.75 c
	Tifblue	42	4.29 a	6.90 ab	nt[5]		
Flower Stage[6]	5	93	2.65 b	6.65 b	85	0.55 b	6.74 b
	6	118	4.14 a	6.67 b	90	1.77 a	6.97 a
	7	68	2.66 b	7.04 a	37	1.81 a	7.08 a

[1]Number of flowers tested. Only data from flower stages 5, 6 and 7 at inoculation are included.
[2]Disease severity rated on a scale of 0 = no visible symptoms to 7=flower cluster dead with lesion extending into stem.
[3]Flower stage two weeks after inoculation rated on scale of 1 to 7 (12).
[4]Numbers followed by the same letter within main effect within columns are not significantly different. LSD, P = 0.05.
[5]nt = not tested.
[6]Flower stage at inoculation.

tal units. Data were subjected to analysis of variance by PROC GLM with PC/SAS software (SAS Institute, Cary, NC). Means were separated by least significant difference (P = 0.05). Only data from flowers at stage 5 to 7 at inoculation were included in analysis comparing cultivar susceptibility.

Results

Since all flower developmental stages were not present on all five cultivars, the effect of flower stage at inoculation on blossom blight severity was analyzed within cultivar and within flower stage (Table 1). 'Magnolia' flowers inoculated at stage 5 and 6 developed more severe disease symptoms than those inoculated at stage 2 and 3. 'Premier' flowers inoculated at stage 6 had higher disease scores than those inoculated at stage 3, 4, and 5. 'Climax' flowers inoculated at stage 7 had higher disease scores than those inoculated at stage 5.

Cultivar comparisons were made using data from flowers inoculated with *B. cinerea* at stage 5 to 7 only. There was not a significant cultivar by flower stage at inoculation interaction. 'Tifblue' and 'Magnolia' flowers received higher disease severity scores than 'Jubilee,' 'Premier' and 'Climax' (Table 2). The occurrence of some *Botrytis* symptoms on uninoculated plants indicates that the pathogen was present on plants in the nursery. Flowers inoculated at stage 6 (fully open with corollas completely expanded) developed more severe *Botrytis* symptoms than flowers inoculated at stage 5 (corollas unexpanded and closed) and stage 7 (corollas dropped).

Discussion

The two southern highbush cultivars did not differ as a group from the three rabbiteye cultivars in their susceptibility to *Botrytis* blossom blight. The southern highbush cultivar Magnolia was as susceptible to *Botrytis* blossom blight as the most susceptible rabbiteye cultivar, Tifblue. The other southern highbush cultivar Jubilee was the least susceptible cultivar in this study.

'Tifblue' and 'Premier' are major cultivars grown in areas such as southern Georgia and northern Florida where *Botrytis* blight is considered a problem (1, 2, 6, 7). The increased susceptibility of flowers of these cultivars at full bloom (stage 6) may explain the severe occurrences of this disease that has occasionally been reported. Weather conditions conductive to *Botrytis* blight occurring at or near full bloom could result in severe *Botrytis* blight particularly if these conditions occurred following frost injury to the blooms. The higher disease severity scores of the three rabbiteye cultivars in this study compared to that reported previously (11) may be due to differences in the virulence of the two *B. cinerea* isolates used in the studies or in more favorable environmental conditions during the two week incubation in the screen house. While *Botrytis* blossom blight does not often occur in southern blueberry fields, it can cause major losses when it does occur. Fungicide applications for control of *Botrytis* blossom blight should begin at flower stage 4 and continue through stage 7 when weather conditions are conducive to infection especially in fields where the disease has previously occurred.

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Preserving a Healthy Fruit Crop Industry in the United States: Part II

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Introduction to Part II

On Saturday July 26, 1997, in Salt Lake City, Utah, the American Pomological Society, in collaboration with the Fruit Breeding Working Group and the Pomology Working Group of the American Society for Horticultural Science, presented a workshop entitled: A Healthy Fruit Crop Industry for North America. This workshop discussed the status of the United States Plant Germplasm Quarantine for temperate fruit crops. The first part of the proceedings were published in Fruit Varieties Journal 52(4):210-219 and included presentations from Dave Weil of the Tree Connection in Dundee, Oregon, and Maxine Thompson, Professor Emeritus from Oregon State University. In addition, a summary of points from the panel-audience discussion was provided.

In Part II, John Hartung, Unit Leader for the USDA, ARS Plant Germplasm Quarantine Office (PGQO), describes recent changes in administration at the Quarantine Unit and Suzanne Hurtt, Plant Pathologist, USDA, ARS PGQO, describes the quarantine procedures used to test pome fruits for exotic diseases. Many of us in fruit research and industry look forward to these positive changes which should enable improved processing of exotic germplasm through quarantine.

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