Species of *Colletotrichum* and *Glomerella* Pathogenic to Tomato Fruit

W. E. BATSON, Professor, and K. W. ROY, Associate Professor, Department of Plant Pathology and Weed Science, Mississippi State University, Mississippi State 39762

ABSTRACT

Batson, W. E., and Roy, K. W. 1982. Species of *Colletotrichum* and *Glomerella* pathogenic to tomato fruit. Plant Disease 66:1153-1155.

Eleven species of *Colletotrichum* and *Glomerella* and one subspecies of *Colletotrichum* were inoculated into detached, ripening tomato fruit. *Colletotrichum* sp. 1, *Colletotrichum* sp. 2, *C. coccodes, C. dematium, C. dematium* var. *truncata, C. destructivum, C. gloeosporioides, C. graminicola, C. trichellum, Glomerella* sp., *G. glycines,* and *G. gossypii* were pathogenic. *C. falcatum* and *C. trifolii* were nonpathogenic. In general, isolates of *Colletotrichum* sp. 1, *C. gloeosporioides, C. dematium,* and *G. glycines* were most aggressive. Differences in virulence among isolates occurred within *G. glycines, Colletotrichum* sp. 1, and *C. gloeosporioides,* with the greatest variability occurring in the latter species. *C. dematium* var. *truncata, C. graminicola, C. trichellum, G. glycines,* and *G. gossypii* are reported as pathogenic to tomato fruit for the first time.

Additional key words: anthracnose, barnyardgrass, big spurge, blue verbena, cocklebur, cowpea, johnsongrass, morninglory, okra, redroot pigweed, ryegrass, spotted spurge, three-seeded mercury, watermelon

Anthracnose is a major disease of fresh market, home garden, and processing tomatoes (2,4,10). It is most serious on processing types, which are allowed to ripen in the field (1,4). The latter condition is conducive to wounding of fruit, which predisposes them to infection (9).

Although *Colletotrichum coccodes* (Wallr.) Hughes is often cited as the primary causal fungus of anthracnose (1,2,9,10), several other anthracnose fungi have been isolated from tomato fruit and their pathogenicity demonstrated in vitro (3,5,8). At least five species of anthracnose fungi have been isolated by us from ripe processing tomatoes in Mississippi.

There is little information on the relative pathogenicity and host range of fungi capable of inciting anthracnose of tomato fruit. This study was conducted to determine the relative ability of 12 anthracnose fungi isolated from various crops and weeds to incite anthracnose when inoculated into tomato fruit.

MATERIALS AND METHODS

Isolation and identification of fungi. Sources of *Colletotrichum* and *Glomerella* isolates used for inoculation of tomato fruit are presented in Table 1. Fungi from tomato and apple were isolated from fruit lesions; others were isolated from leaf spots. Sections from the margins of diseased leaf and fruit tissue were surface-sterilized with 1% sodium hypochlorite, plated on Difco potato-dextrose agar (PDA), and incubated at 22 C. Species of *Colletotrichum* and *Glomerella* growing from plated material were identified or, to induce sporulation and facilitate identification, were cultured on sections of sterilized soybean stems in test tubes, on V-8 juice agar, or on PDA. Descriptions of *Colletotrichum* or *Glomerella* species reported by von Arx (13), Mordue (6,7), Sutton (11), and Tiffany and Gilman (12) were utilized for species determination.

Inoculation of tomato fruit. Sections of broom straw approximately 5 mm long and 1 mm in diameter were placed on 5-day-old PDA cultures of each fungus, incubated at 22 C for 1 wk, and used as inoculum.

Ripe tomato fruits from the market, selected for uniformity in size and maturity, were surface-sterilized in 0.5% sodium hypochlorite for 1 min, rinsed three times in tap water, and allowed to dry. Six replicate fruits were inoculated per fungus by inserting infested straws into fruit using a sterile forceps, after which points of inoculation were covered with petrolatum. Fruits similarly treated with noninfested straws served as controls. The treatments and controls were completely randomized and incubated in the dark at 28 C. This experiment was conducted three times.

Disease rating. Disease severity was evaluated 3 days after inoculation using the following visual rating scale based on lesion diameter: 1 = no anthracnose lesion, 2 = lesions $\leq$5 mm, 3 = lesions 6–10 mm, 4 = lesions 11–15 mm, and 5 = lesions $>$15 mm.

Isolation of fungi from inoculated fruit. Three days after inoculation, the fruit epidermis surrounding the point of inoculation was swabbed with 95% ethanol, peeled back with a sterile forceps, and a small portion of tissue aseptically removed from beneath and plated on PDA. The plated tissue was incubated at 22 C for 1 wk, during which fungi growing from it were identified.

RESULTS AND DISCUSSION

All fungal isolates except *C. falcatum* and *C. trifolii* were pathogenic (Table 1) and reisolated from lesions on inoculated fruit. *C. dematium* var. *truncata, C. graminicola, C. trichellum, G. glycines,* and *G. gossypii* are recorded as pathogenic to tomato fruit for the first time. Thirty-one of the pathogenic isolates incited lesions rating a disease index of 4, 13 an index of 3, and five an index of $<$3. Additionally, two isolates of *Colletotrichum* sp. 1 (W2-6 and BG-3) and one of *Glomerella* sp. (VV-1) tested but excluded from the statistical analysis were highly pathogenic. Disease indexes for fruit infected with W2-6, BG-3, and VV-1 were 4.7, 4.7, and 4.8, respectively.

Colletotrichum sp. 1, a falcate-spored fungus, was provisionally identified as *C. dematium.* We refer to it by the former name to distinguish it from *C. dematium* and *C. dematium* var. *truncata,* whose identities are not in doubt. According to von Arx (13), *C. trichellum, C. graminicola,* and *C. dematium* are the only falcate-spored *Colletotrichum* species. *Colletotrichum* sp. 1 is neither *trichellum* nor *graminicola,* and although it can be referred to as *dematium* using von Arx's broad concept of this species, it differs from *dematium* in growth rate, size and shape of conidia, and morphology of appressoria (Roy, *unpublished*). Thus, it appears that there is ample justification for distinguishing between *Colletotrichum* sp. 1 and *C. dematium.* A comparative study of the morphology and pathogenicity of these two fungi is currently being conducted.

In general, isolates of *Colletotrichum* sp. 1, *C. gloeosporioides* (= *G. cingulata* (Stonem.) Spauld. & Schrenk), *C. dematium,* and *G. glycines* were the most aggressive (Table 1). *C. destructivum* and two isolates of *Colletotrichum* sp. 1 (JG-2 and JG-3) were least aggressive. *Colletotrichum* sp. 2, *C. graminicola, C. trichellum,* and *G. gossypii* did not differ

Published with the approval of the director, Mississippi Agricultural and Forestry Experiment Station, as Paper 5030.

Accepted for publication 24 March 1982.

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

0191-2917/82/12115303/$03.00/0
©1982 American Phytopathological Society

in pathogenicity. *C. dematium* was more aggressive than *C. trichellum* and two isolates of *C. dematium* var. *truncata* (T-2 and T-3). These data indicate that even though *C. coccodes* is emphasized in screening for resistance to anthracnose (1,2), other species may be of equal or greater importance and should, as Barksdale (3) cautioned, be considered in screening programs. In addition, the relative pathogenicity of species should be considered in establishing priorities for such programs.

Within some fungal species, statistically significant differences in virulence occurred among isolates, occasionally even among isolates from the same host, and the magnitude of these differences varied among species. Such differences—which occurred within *Colletotrichum* sp. 1, *C. gloeosporioides,* and *G. glycines,*

Table 1. Relative ability of *Colletotrichum* and *Glomerella* isolates from various hosts to incite anthracnose lesions when inoculated on tomato fruit in vitro

Fungus	Isolate no.	Source		Disease rating[s]
		Common name	Scientific name	
Colletotrichum sp. 1	BP-4	Sweet pepper	*Capsicum annuum* L.	5.0 a
C. gloeosporioides (Penz.) Sacc.	WM-1	Watermelon	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	5.0 a
Glomerella glycines Hori	GG-1	Soybean	*Glycine max* (L.) Merr.	5.0 a
Colletotrichum sp. 1	OK-1	Okra	*Abelmoschus esculentus* (L.) Moench.	4.9 a
Colletotrichum sp. 1	W8-7	Big spurge	*Euphorbia nutans* L.	4.9 a
Colletotrichum sp. 1	MG-1	Morningglory	*Ipomoea purpurea* (L.) Roth	4.9 a
C. gloeosporioides	CB-6	Cocklebur	*Xanthium pennsylvanicum* Wallr.	4.9 a
Colletotrichum sp. 1	BD-1	Broadleaf dock	*Rumex obtusifolius* L.	4.9 a
Colletotrichum sp. 1	W1-1	Pigweed	*Amaranthus* sp.	4.9 a
Colletotrichum sp. 1	W4-2	Spotted spurge	*Euphorbia maculata* L.	4.9 a
Colletotrichum sp. 1	CF-1	Soybean	*G. max*	4.8 ab
Colletotrichum sp. 1	CB-4	Cocklebur	*X. pennsylvanicum*	4.8 ab
C. gloeosporioides	CB-5	Cocklebur	*X. pennsylvanicum*	4.8 ab
Colletotrichum sp. 1	WM-2	Watermelon	*C. lanatus*	4.8 abc
C. gloeosporioides	BP-1	Sweet pepper	*C. annuum*	4.8 abc
Colletotrichum sp. 1	W2-1	Redroot pigweed	*Amaranthus retroflexus* L.	4.7 abcd
C. dematium (Fr.) Grove	W8-6	Big spurge	*E. nutans*	4.7 abcd
G. glycines	OK3-A	Okra	*A. esculentus*	4.6 abcde
C. dematium	AF-4	Alfalfa	*Medicago sativa* L.	4.6 abcde
Colletotrichum sp. 1	CX-1	Tomato	*Lycopersicon esculentum* Mill.	4.6 abcdef
C. dematium	RC-1	Red clover	*Trifolium pratense* L.	4.6 abcdef
Colletotrichum sp. 1	CP-1	Cowpea	*Vigna unguiculata* (L.) Walp.	4.5 abcdef
G. gossypii Edg.	GGS-3	Cotton	*Gossypium hirsutum* L.	4.2 bcdefg
G. glycines	CP-6	Cowpea	*V. unguiculata*	4.2 cdefg
C. gloeosporioides	GTC-1	Soybean	*G. max*	4.1 defgh
C. coccodes (Wallr.) Hughes	RG-2	Ryegrass	*Lolium multiflorum* Lam.	4.1 efgh
C. gloeosporioides	KZ-2	Kudzu	*Pueraria lobata* (Willd.) Ohwi.	4.1 efgh
C. gloeosporioides	GC-2	Sweet pepper	*C. annuum*	4.1 efgh
C. graminicola (Ces.) Wilson	CG-1[t]	Alfalfa	*M. sativa*	4.1 efgh
C. gloeosporioides	AF-1	Alfalfa	*M. sativa*	4.0 efghi
Colletotrichum sp. 2	RG-1	Ryegrass	*L. multiflorum*	4.0 efghi
C. dematium Grove var. *truncata* (Schw.) v. Arx	T-1	Soybean	*G. max*	3.9 fghi
C. trichellum (Fr.) Duke	TC-5[u]	Bamboo	*Bambusa*	3.8 ghi
C. gloeosporioides	RC-2	Red clover	*T. pratense*	3.8 ghij
C. coccodes	CX-3	Tomato	*L. esculentum*	3.8 ghij
C. gloeosporioides	GC-3	Soybean	*G. max*	3.8 ghij
C. dematium var. *truncata*	T-3	Purple nutsedge	*Cyperus rotundus* L.	3.8 ghij
Colletotrichum sp. 1	CX-2	Tomato	*L. esculentum*	3.8 ghij
C. gloeosporioides	W3-2	Three-seeded mercury	*Acalypha ostryaefolia* L.	3.7 ghij
C. dematium var. *truncata*	T-2[v]	Soybean	*G. max*	3.7 ghij
Colletotrichum sp. 1	CT-4	Cotton	*G. hirsutum*	3.5 hij
C. gloeosporioides	GC-1[w]	Apple	*Malus sylvestris* Mill.	3.4 ij
C. gloeosporioides	W3-1	Three-seeded mercury	*A. ostryaefolia*	3.2 jk
C. gloeosporioides	W4-6	Spotted spurge	*E. maculata*	3.2 jk
G. glycines	W8-4	Big spurge	*E. nutans*	2.8 kl
C. gloeosporioides	W6-1	Pigweed	*Amaranthus* sp.	2.7 kl
C. destructivum O'Gara	CDS-2[x]	Alfalfa	*M. sativa*	2.6 l
Colletotrichum sp. 1	JG-3	Johnsongrass	*Sorghum halepense* (L.) Pers.	2.5 l
Colletotrichum sp. 1	JG-2	Johnsongrass	*S. halepense*	1.8 m
C. falcatum Went	CFC-3[y]	Sugarcane	*Saccharum officinarum* L.	1.6 mn
C. trifolii Bain & Essary	CTF-1[z]	Alfalfa	*M. sativa*	1.2 n
Control				1.0 n

[s] Figures followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple range test. Disease rating scale based on lesion diameter: 1 = no anthracnose lesions, 2 = lesions ≤5 mm, 3 = lesions 6–10 mm, 4 = lesions 11–15 mm, and 5 = lesions >15 mm.

[t] ATCC 11870.

[u] ATCC 34168.

[v] ATCC 18013.

[w] Cultures obtained from L. E. Trevathan, Department of Plant Pathology and Weed Science, Mississippi State University.

[x] ATCC 11869.

[y] ATCC 12088.

[z] ATCC 32358.

with the greatest variability occurring within *C. gloeosporioides*—indicate that choice of isolate may be an important consideration in screening for resistance.

Within pathogenic species, 26 isolates originated from 10 different crops (other than tomato) and an equal number from 14 different weeds. Some are newly recorded on certain hosts: *Colletotrichum* sp. 1 on watermelon, redroot pigweed, spotted spurge, big spurge, johnsongrass, cocklebur, morningglory, and barnyardgrass; *C. gloeosporioides* on spotted spurge and three-seeded mercury; *C. coccodes* on ryegrass; *C. dematium* on big spurge; *Colletotrichum* sp. 2 on ryegrass; *G. glycines* on okra, cowpea, and big spurge; and *Glomerella* sp. on blue verbena.

Our data suggest that numerous species of anthracnose fungi are potentially capable of infecting injured tomato fruit in the field. Further, they suggest that numerous crops and weeds, common in Mississippi and elsewhere, could serve as sources of inoculum. The extent to which these fungi occur on these hosts needs to be determined because it could have important implications in the epidemiology and control of anthracnose.

LITERATURE CITED

1. Barksdale, T. H. 1970. Resistance to anthracnose in tomato introductions. Plant Dis. Rep. 54:32-34.
2. Barksdale, T. H. 1971. Inheritance of tomato anthracnose resistance. Plant Dis. Rep. 55:253-256.
3. Barksdale, T. H. 1972. Resistance in tomato to six anthracnose fungi. Phytopathology 62:660-663.
4. Farley, J. D. 1976. Survival of *Colletotrichum coccodes* in soil. Phytopathology 66:640-641.
5. Gourley, C. O. 1966. The pathogenicity of *Colletotrichum dematium* to table beets and other hosts. Can. J. Plant Sci. 46:531-536.
6. Mordue, J. E. M. 1967. *Colletotrichum coccodes, C. graminicola,* and *Glomerella tucumanensis.* Descriptions of Pathogenic Fungi and Bacteria. Nos. 131, 132, and 133. Commonw. Mycol. Inst./Assoc. Appl. Biol., Kew, Surrey, England.
7. Mordue, J. E. M. 1971. *Glomerella cingulata, Colletotrichum lindemuthianum,* and *C. capsici.* Descriptions of Pathogenic Fungi and Bacteria. Nos. 315, 316, and 317. Commonw. Mycol. Inst./Assoc. Appl. Biol., Kew, Surrey, England.
8. Pantidou, M. E., and Schroeder, W. T. 1955. Foliage as a source of secondary inoculum for tomato anthracnose. Phytopathology 45:338-345.
9. Robbins, M. L., and Angell, F. F. 1970. Tomato anthracnose: A hypodermic inoculation technique for determining genetic reaction. J. Am. Soc. Hortic. Sci. 95:118-119.
10. Stevenson, W. R., Evans, G. E., and Barksdale, T. H. 1978. Evaluation of tomato breeding lines for resistance to fruit anthracnose. Plant Dis. Rep. 62:937-940.
11. Sutton, B. C. 1962. *Colletotrichum dematium* and *C. trichellum.* Trans. Br. Mycol. Soc. 45:222-232.
12. Tiffany, L. H., and Gilman, J. C. 1954. Species of *Colletotrichum* from legumes. Mycologia 46:52-75.
13. von Arx, J. A. 1970. Revision of the Fungi Classified as *Gloeosporium.* J. Cramer, Lehre, New York. 203 pp.