

Characterization of *Colletotrichum graminicola* populations from a sorghum hybrid CSH 9 for morphological and pathogenic variability

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ABSTRACT: During a field survey in the 1994 rainy season a popular commercial sorghum hybrid CSH 9 was found showing anthracnose (*Colletotrichum graminicola*) symptoms in several farmers' fields in Maharashtra state of India. About 100 single-lesion isolates obtained from representative leaf samples from four fields of CSH 9 and one field of a local sorghum cultivar (LSC) were characterized and compared for morphological and pathogenic variability. The representative single-lesion isolates and their derivatives varied significantly for morphological traits - colony color, growth pattern, spore size and sporulation rate on oatmeal agar medium. These isolates also exhibited significant variation for latent period, virulence, aggressiveness, and virulence index on a set of sorghum differential lines in a greenhouse test. The isolate from the LSC, although differed morphologically from those of CSH 9, did infect CSH 9 and its parental lines, indicating a virulence shift in the *C. graminicola* population from the local sorghum to hybrid CSH 9.

Key words: Sorghum anthracnose, pathogenic variability, virulence index

Anthracnose of sorghum [*Sorghum bicolor* (L.) Moench], caused by *Colletotrichum graminicola* (Ces.) Wils., is a highly variable pathogen (Ali and Warren, 1987; Casela and Ferreira, 1995; Thomas, 1995; Warren, 1986). Based on differential reaction on sorghum lines, some 44 races/pathotypes have been reported from different countries—Brazil (Ferreira and Caseia, 1986), northern Nigeria (Ozoula *et al.*, 1986), US and Puerto-Rico (Ali and Warren, 1987; Cardwell *et al.*, 1989), India (Pande *et al.*, 1991) and western Africa (Thomas, 1995). It is well recognized that pathogenic variability poses difficulty in development and deployment of effective host resistance, which is a dependable and economic means of disease management. In India, several sorghum hybrids with multiple disease resistance are cultivated commercially, and CSH 9 is one of the most popular hybrids widely grown in several states. During a survey of sorghum anthracnose in the 1994 rainy season in Maharashtra, anthracnose was observed on leaves of CSH 9 in several fields, and a number of leaf samples were collected both from CSH 9 and a local sorghum cultivar. This study was conducted to determine the comparative morphological and pathogenic

diversity among the *C. graminicola* populations from the twocultivars to help understand the evolution of new virulence in the pathogen and effectiveness of resistance stability/durability in the cultivar.

MATERIALS AND METHODS

The pathogen isolates

During a field survey in the 1994 rainy season about 50 anthracnose-infected leaf samples were collected from several fields of a popular commercial sorghum hybrid CSH 9 and a local sorghum cultivar (LSC) in Maharashtra state of India. The leaf samples were blotter dried and stored at 4°C until used. The leaf samples were visually examined for lesion types, and four representative samples with typical anthracnose lesions from CSH 9 and one from LSC were selected for the study. These collections, made from different villages of three districts, were designated Cg 022 (CSH 9, Vadalg, Sholapur), Cg 088 (CSH 9, Botibhori, Nagpur), Cg 089 (CSH 9, Limba, Nagpur), Cg 090 (CSH 9, Linga, Nagpur) and Cg 093 (LSC, Kolambi, Yavatmal). From each collection 20 single-lesion bits (2mm x 2 mm) were cut, surfaced sterilized with 0.1% HgCl₂ solution for 2 min, rinsed twice in

Table 1. Colony characteristics of five original isolates and seven morphological variants of *Colletotrichum graminicola*, 10 days after incubation at 25°C on oatmeal agar plates

Isolate designation	Mycelial growth	Color	Acervulus	No. of setae/ acervulus	Apprcs-soria	Sclerotia
Cg 022	Raised, felty	White	Distinct	2-3	+	+
Cg 088	Raised, felty	Lilac-white-grey	Distinct	14	+	+
Cg 088 B	Raised, felty	Grey	Indistinct	1-2	+	+
Cg 088 C	Submerged, felty	Lilac-white	Indistinct	1-2	+	-
Cg 088 D	Raised, felty	Grey	Indistinct	1-2	-	-
Cg 088 E	Submerged, felty	White-grey	Distinct	3-4	-	-
Cg 089	Raised, felty	Greyish white	Distinct	1-30	+	+
Cg 089 A	Raised, felty	Greyish white	Indistinct	1-2	+	-
Cg 089 B-1	Submerged, wooly	Grey	Distinct (Aggregates)	10-15	-	+
Cg 089 B-2	Submerged, felty	White	Distinct (Pin-heads like)	20-30	-	-
Cg 090	Submerged, felty	Grey-green	Distinct	5-6	-	+
Cg 093	Raised, felty	Greyish white	Distinct	3-4	+	+

+ Present; - Absent

Table 2. Virulence index (VI)^a of five original and seven morphological variants of *Colletotrichum graminicola* on nine sorghum lines

Isolate designation	Sorghum lines									Mean
	A 2267-2	IRAT-204	IS 3758	IS S354	IS 3089	IS 18442	CSH-9	296B	CS 3541	
Cg 022	2.2	16	3.2	5.4	5.8	5.4	2.4	2.4	2.1	3.4
Cg 088	1.7	3.8	3.6	3.5	6.8	5.8	4.0	4.0	4.3	4.2
Cg 088B	1.0	4.0	3.6	2.5	3.0	5.8	4.6	4.0	3.0	3.5
Cg 088C	15	5.6	2.8	7.6	8.6	8.4	3.4	5.0	4.6	5.3
Cg 088D	1.0	3.6	6.2	4.8	8.2	6.2	1.7	1.0	2.6	3.9
Cg 088E	1.9	5.8	7.4	4.0	6.2	8.8	13	13	2.1	4.3
Cg 089	1.0	15	10	3.2	2.3	1.8	18	18	3.4	2.0
Cg 089A	4.4	2.0	2.9	3.5	2.4	3.9	3.1	2.6	4.1	2.1
Cg 089B-1	1.8	18	15	1.0	2.1	2.3	2.9	3.0	3.0	3.2
Cg 089B-2	1.0	14	10	3.2	2.3	2.3	3.4	10	3.0	2.1
Cg 090	2.2	3.0	2.1	2.3	1.9	2.3	15	3.0	1.8	2.2
Cg 093	1.0	10	6.7	4.0	2.5	8.5	8.2	6.4	9.7	5.3
Genotype mean	1.7	2.9	3.5	3.8	4.3	5.1	3.2	3.0	3.6	

^aVI = [1+ (virulence x aggressiveness) x latent period⁻¹]LSD for VI ($P < 0.001$) for isolate = 0.623, sorghum line = 0.61, isolate x line = 1.38

and Cg 089 (2.7 days). Sorghum lines also varied significantly in the latent period across the 12 isolates. IRAT 204 showed the shortest mean latent period (2.9 days), while IS 3758 had the longest (4.2 days). The pathogen isolate x host line interaction for the latent period was highly significant ($P < 0.001$).

Virulence

Among the isolates, Cg 088 was the most virulent as it induced S reaction on eight lines, and MR reaction on one line (data combined with virulence index, Table 2). Among the variants of Cg 088, Cg 088C and

Cg 088E infected all the nine lines, but these two varied in reaction on specific lines. The nine sorghum lines reacted differentially to the isolates. A 2267-2 developed S reaction to two, MR to five and R to five isolates, while CSH 9 developed S reaction to eight (including Cg 093 from LSC), and MR to four. Line 296B very well differentiated the parental and their variant isolates. Similarly, CS 3541 also exhibited S reaction to three and MR to original isolates, but showed S/MR to the variants within Cg 088 and Cg 089. Of the two parents of CSH 9, CS 3541 showed S/MR to all the 12 isolates, while 296B to 10. These differences in

more host lines, and thus may have implications for cultivar resistance stability.

The isolates from CSH 9 exhibited S reaction on A 2267-2, which was found resistant to *C. graminicola* isolates from several Indian locations both under field and greenhouse tests (ICRISAT, 1996; Pande *et al.*, 1991). Existence of morphologically variable pathotypes has also been reported in other species of *Colletotrichum*, such as *C. gloeosporioides* (Irwin and Cameron, 1978) and *C. trifolii* (O'Neill, 1996). However, in the present study, isolates from a single host cultivar (CSH 9) from different fields within one state were found to be distinct pathotypes and these were different from those obtained from the LSC. However, the LSC isolate could readily infect CSH 9 and its parental lines (296B and CS 3541) indicating a virulence shift in *C. graminicola* populations from LSC to CSH 9. CSH 9 is a popular commercial cultivar, and CS 3541 is the pollen parent of two other popular sorghum hybrids CSH 5 and CSH 6. In view of the evolution of new virulence in *C. graminicola* populations specific to known resistance of CSH 9 and its parental lines there is a need to monitor the resistance stability of the existing commercial hybrid cultivars through field survey and virulence analysis. This is important for strategic utilization and deployment of effective resistance to prevent or reduce high susceptibility of improved sorghum cultivars.

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