

Anthracnose Disease Response for Photoperiod-Insensitive Ethiopian Germplasm from the U.S. Sorghum Collection

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Abstract: Ethiopia is an important center of genetic diversity for sorghum germplasm; however, photoperiod-sensitivity limits the utilization of this genetic resource. The United States National Plant Germplasm System maintains 180 Ethiopian sorghum accessions that are less sensitive to photoperiod and these accessions were inoculated with *Colletotrichum sublineolum* and evaluated for disease resistance at the Tropical Agriculture Research Station in Isabela, Puerto Rico during the 2008 and 2009 growing seasons. Disease response was similar across growing seasons, with 35 accessions rated as resistant and 98 accessions showing a susceptible response to anthracnose. Variation for disease resistance across growing seasons and replications was observed for 47 accessions and these accessions also showed low mean infection severity. Eighteen accessions showed a highly susceptible response across growing seasons with plant death before maturity observed for nine accessions. Disease severity was also similar for the two growing seasons with a mean infection severity of 23.4% for the 136 accessions rated as susceptible in 2008 and 22.6% for the 140 accessions rated as susceptible in 2009. Although the frequency of anthracnose resistant accessions was low for this germplasm subset, the collection showed phenotypic diversity suggesting possible genetic variation for anthracnose resistance that would be beneficial for sorghum improvement.

Key words: Ethiopian germplasm % Anthracnose resistance % Disease screening % *Sorghum bicolor*

INTRODUCTION

Sorghum anthracnose, *Colletotrichum sublineolum* (P. Henn. in Kabat and Bubák), is typically observed on the leaves of the sorghum plant and the disease occurs worldwide [1]. Symptoms of foliar infection appear as circular or elliptical lesions with acervuli, the asexual fruiting bodies of the fungus, in the center of the lesions. Lesions may appear within 30 days after seedling emergence and, for highly susceptible varieties, lesions will coalesce and can rapidly spread to all leaves resulting in leaf senescence. Plant death before maturity has been observed for highly susceptible germplasm accessions evaluated in Puerto Rico [2]. Grain yield losses due to fungal infection are commonly associated with a reduction in grain size and reported yield losses ranged from 30 to 67% [3-5]. Resistant varieties can be successfully used to manage the disease. However, multiple sources of resistance are needed since the pathogen population is highly variable and new pathotypes can overcome

available sources of resistance [6-10]. Sorghum germplasm from Ethiopia has been a valuable source of genetic variation for the development of grain sorghum breeding lines in the United States and the germplasm collection may also harbor genetic diversity for anthracnose resistance. However, in temperate climatic regions, photoperiod-sensitivity limits the utilization of germplasm from the collection. Therefore, the photoperiod-insensitive accessions from the Ethiopian germplasm collection were evaluated for anthracnose disease response to identify resistant accessions for sorghum improvement.

MATERIALS AND METHODS

The Ethiopian sorghum collection maintained by the United States Department of Agriculture, Agricultural Research Service (USDA-ARS), National Plant Germplasm System includes 215 accessions that are less sensitive to photoperiod and will flower in temperate climatic regions

during the summer growing season [11]. Seed samples available for 180 accessions were obtained from the USDA-ARS, Plant Genetic Resources Conservation Unit in Griffin, Georgia and evaluated for anthracnose resistance at the USDA-ARS, Tropical Agriculture Research Station in Isabela, Puerto Rico. In addition, 18 control genotypes selected based on previous disease evaluations were included in the evaluation as follows: Ten susceptible control genotypes, PI 152714, PI 173112, PI 211633, PI 533772 (SC271), PI 533831 (SC414), PI 534157 (SC170), PI 561472 (Sureño), PI 564163 (BTx623), PI 609251, PI 641848 and eight resistant control genotypes, NSL 4025 (Redlan), PI 250582, PI 533794 (SC110), PI 533909 (SC48), PI 533991 (SC748), PI 534131 (SC30), PI 535792, PI 595735 (SC1313). The first evaluation was planted 27 June 2008 and the second evaluation was planted 6 April 2009. The two evaluations corresponded to the rainy growing season in Puerto Rico. The experiment was planted in a randomized complete block design with three replications. Each accession was planted in a single row of 1.8 m in length with 0.9 m spacing. A border row of an anthracnose susceptible genotype (PI 561472) was planted around the experimental fields. Lorsban 15G (Chlorpyrifos) granular insecticide (Dow AgroSciences, Indianapolis, IN) was applied at a rate of 8 kg/ha during planting to prevent seed loss from fire ants. Weeds were controlled with mechanical tillage and hand hoeing. No fertilizer was required for the 2008 evaluation and 560 kg/ha (15-5-10 NPK) was applied 39 days after planting for the 2009 evaluation. Irrigation was carried out using overhead sprinklers and three applications were conducted in 2008 before inoculation. For the 2009 evaluation, six irrigation applications were conducted before inoculation. No irrigation was conducted after inoculation for either of the two evaluations. In 2008, rainfall events occurred on 23 days before inoculation with a total of 88 mm received and, after inoculation, a total of 441 mm was received with rainfall events occurring on 32 days. Less rainfall was received in 2009 with a total of 108 mm received before inoculation that occurred on 22 days. After inoculation, rainfall occurred on 41 days with a total of 311 mm received.

Anthracnose fungal cultures used for seed colonization were prepared from infected leaf samples randomly collected from experimental fields at the research location in Isabela, Puerto Rico to represent the pathotype population as described by Erpelding and Prom [12]. Inoculations were conducted 39 days after planting in 2008 and 38 days after planting in 2009 using anthracnose-colonized sorghum seed placed in the leaf

whorl of each plant [13]. Disease symptoms were evaluated 30, 41 and 57 days after inoculation in 2008 and 14, 28, 42 and 62 days after inoculation in 2009. Inoculated plants within a row were rated visually using a 1 to 5 scale based on disease symptoms observed on inoculated leaves and disease progression on non-inoculated leaves [13]. Lesion formation with the development of acervuli in the center of the lesions was considered a susceptible response. Resistant plants rated as 1 showed no disease symptoms and plants rated as 2 showed the formation of red spots or reddening of inoculated leaves. Moderately susceptible plants rated as 3 showed chlorotic lesion development with acervuli on inoculated leaves. Susceptible plants rated as 4 and highly susceptible plants rated as 5 showed necrotic lesion development with abundant acervuli on inoculated leaves and disease progression on non-inoculated leaves. For plants rated as 5, disease symptoms were observed on most leaves including the flag leaf and senescence of inoculated leaves was commonly observed. The disease severity rating was based on a visual evaluation of the percentage of infected leaf area for the susceptible plants in each row [13]. Approximately 20 plants within each row were evaluated for the presence of acervuli on infected leaves and compared to the total number of leaves per plant to provide an overall visual estimate of disease severity for the row. Analysis of variance was conducted on the disease severity data from the final rating using the Statistix 9 software package (Analytical Software, Tallahassee, FL) [13]. Mean comparisons for disease severity were conducted using Tukey's standardized range test at the 5% probability level [13].

RESULTS

The majority of the 180 Ethiopian photoperiod-insensitive sorghum accessions were rated as susceptible (Table 1). For the 2008 disease evaluation, 136 accessions were rated as susceptible and 99 accessions showed a susceptible response across replications. Variation in susceptibility across replications was observed for 37 accessions, with 15 accessions showing a susceptible response across two replications and 22 accessions rated as susceptible in one replication. A highly susceptible response across replications was observed for 22 accessions and plant death before maturity occurred for seven accessions. Approximately 35% of the susceptible accessions showed acervuli developed on the flag leaf within 57 days after inoculation. The majority of the susceptible accessions showed a susceptible response

within 30 days after inoculation (data not shown). For the 122 accessions rated as susceptible 30 days after inoculation, 78 accessions showed a susceptible response across replications and 17 accessions showed acervuli development on the flag leaf. At 41 days after inoculation, 132 accessions were rated as susceptible with 94 accessions showing a susceptible response across replications (data not shown). The 44 accessions rated as resistant showed reddening of inoculated leaves within 7 days after inoculation and acervuli development was not observed on leaves during the final evaluation.

Similar results were observed for the 2009 evaluation with 40 accessions rated as resistant (Table 1). A susceptible response across replications was observed for 112 of the 140 accessions rated as susceptible in 2009. For the 28 accessions that showed variation in susceptibility across replications, 10 accessions showed a susceptible response across two replications and 18 accessions showed a susceptible response in one replication. Plant death before maturity was observed for five of the 27 accessions rated as highly susceptible

across replications. For one highly susceptible accession, plant death occurred before flowering and stalk rot resulted in severe lodging with the plants completely degraded by the final evaluation. Acervuli development on inoculated leaves was observed for 100 accessions within 14 days after inoculation (data not shown). A susceptible response across replications was observed for 87 of the 126 accessions rated as susceptible 28 days after inoculation. However, disease progression was slower in 2009 with seven accessions rated as highly susceptible and only one accession was rated as highly susceptible across replications 28 days after inoculation. For the evaluation conducted 42 days after inoculation, 135 accessions were rated as susceptible (data not shown). A susceptible response across replications was observed for 102 accessions with nine accessions rated as highly susceptible across replications 42 days after inoculation. The majority of the accessions that showed variation in susceptibility across replications for the final evaluation also showed variation across replications 28 and 42 days after inoculation.

Table 1: Anthracnose disease rating and mean infection severity data for 180 photoperiod-insensitive Ethiopian sorghum accessions inoculated with *Colletotrichum sublineolum* and evaluated for disease resistance during the 2008 and 2009 growing seasons in Isabela, Puerto Rico

Accession ¹	2008		2009	
	Disease Rating ²	Disease Severity (%) ³	Disease Rating	Disease Severity (%)
PI 195042	2	0.0a	2	0.0a
PI 257602	2	0.0a	2	0.0a
PI 267583	2	0.0a	2	0.0a
PI 267615	2	0.0a	2	0.0a
PI 273969	2	0.0a	2	0.0a
PI 276839	2	0.0a	2	0.0a
PI 329353	2	0.0a	2	0.0a
PI 329752	2	0.0a	2	0.0a
PI 329785	2	0.0a	2	0.0a
PI 329788	2	0.0a	2	0.0a
PI 329790	2	0.0a	2	0.0a
PI 329794	2	0.0a	2	0.0a
PI 329802	2	0.0a	2	0.0a
PI 329803	2	0.0a	2	0.0a
PI 329810	2	0.0a	2	0.0a
PI 330257	2	0.0a	2	0.0a
PI 330263	2	0.0a	2	0.0a
PI 330867	2	0.0a	2	0.0a
PI 330918	2	0.0a	2	0.0a
PI 453813	2	0.0a	2	0.0a
PI 454977	2	0.0a	2	0.0a
PI 454997	2	0.0a	2	0.0a
PI 455088	2	0.0a	2	0.0a
PI 455107	2	0.0a	2	0.0a
PI 455140	2	0.0a	2	0.0a
PI 455141	2	0.0a	2	0.0a
PI 455142	2	0.0a	2	0.0a
PI 455231	2	0.0a	2	0.0a
PI 455529	2	0.0a	2	0.0a
PI 455558	2	0.0a	2	0.0a
PI 455830	2	0.0a	2	0.0a
PI 457714	2	0.0a	2	0.0a

Table 1: Continued

PI 563097	2	0.0a	2	0.0a
PI 563333	2	0.0a	2	0.0a
PI 585506	2	0.0a	2	0.0a
PI 329359	2	0.0a	2\2\4	0.1a
PI 453770	2	0.0a	2\2\4	0.1a
PI 454991	2	0.0a	2\2\4	0.1a
PI 455050	2	0.0a	2\2\4	0.1a
PI 455001	2	0.0a	2\2\4	0.2a
PI 329786	2	0.0a	2\2\4	0.3a
PI 330255	2	0.0a	2\2\4	0.3a
PI 452556	2	0.0a	2\2\4	0.3a
PI 455531	2	0.0a	2\4\4	7.0a-f
PI 337678	2\2\4	0.2a	2	0.0a
PI 457715	2\2\4	0.2a	2	0.0a
PI 457861	2\2\4	0.2a	2	0.0a
PI 454996	2\2\4	3.3ab	2	0.0a
PI 330914	2\2\4	0.2a	2\2\4	1.0ab
PI 455836	2\2\4	0.2a	2\2\4	0.3a
PI 305036	2\2\4	0.3a	2\2\4	3.3a-d
PI 456001	2\2\4	3.3ab	2\2\4	0.3a
PI 329812	2\2\4	0.3a	2\4\4	0.5ab
PI 330915	2\2\4	0.3a	2\4\4	6.7a-f
PI 455209	2\2\4	0.3a	2\4\4	0.5ab
PI 330871	2\2\4	1.7a	2\4\4	3.7a-d
PI 329771	2\2\4	3.3ab	2\4\4	0.2a
PI 453810	2\2\4	3.3ab	2\4\4	0.7ab
PI 455544	2\2\4	3.3ab	2\4\4	0.3a
PI 329446	2\2\4	0.3a	4	0.4a
PI 305056	2\2\4	0.3a	4	0.8ab
PI 251637	2\2\4	0.2a	4	0.9ab
PI 455470	2\2\4	0.2a	4	1.0ab
PI 257599	2\2\4	1.7a	4	2.0ab
PI 455094	2\2\4	0.7a	4	5.3a-e
PI 585481	2\2\4	1.7a	4\5\5	8.3a-f
PI 456199	2\4\4	0.5a	2	0.0a
PI 455091	2\4\4	0.3a	2\2\4	0.1a
PI 585480	2\4\4	0.3a	2\2\4	0.3a
PI 457862	2\4\4	0.5a	2\2\4	0.2a
PI 329777	2\4\4	0.7a	2\2\4	0.3a
PI 329468	2\4\4	1.8a	2\2\4	0.2a
PI 452688	2\4\4	4.0ab	2\4\4	0.4a
PI 457858	2\4\4	6.8a-d	2\4\5	1.8ab
PI 329744	2\4\4	0.5a	4	2.7a-d
PI 455096	2\4\4	0.7a	4	11.7a-g
PI 455528	2\4\4	3.7ab	4	0.8ab
PI 457747	2\4\4	0.5a	4	0.1a
PI 455543	2\4\4	0.8a	4\4\5	11.0a-g
PI 302134	2\4\4	3.7ab	4\5\5	12.0a-g
PI 193609	2\4\5	25.0a-j	4\4\5	33.7d-k
PI 457859	4	4.0ab	2\2\4	1.0ab
PI 455540	4	0.8a	4	0.8ab
PI 456377	4	1.0a	4	3.0a-d
PI 455093	4	1.2a	4	3.7a-d
PI 455541	4	1.2a	4	2.2a-c
PI 455435	4	2.2a	4	4.3a-e
PI 455628	4	2.2a	4	7.7a-f
PI 454989	4	4.0ab	4	4.3a-e
PI 455559	4	4.3a-c	4	1.0ab
PI 305015	4	5.2a-c	4	1.2ab
PI 453771	4	6.7a-d	4	3.7a-d
PI 457860	4	6.7a-d	4	23.3a-j
PI 329434	4	7.0a-d	4	5.7a-f
PI 563095	4	7.0a-d	4	15.0a-h
PI 330050	4	10.0a-e	4	6.7a-f
PI 330127	4	10.0a-e	4	5.7a-f
PI 330869	4	10.0a-e	4	16.7a-i

Table 1: Continued

PI 337700	4	10.0a-e	4	10.0a-g
PI 329266	4	11.7a-f	4	16.7a-i
PI 257597	4	13.3a-g	4	18.3a-i
PI 452687	4	13.3a-g	4	6.0a-f
PI 455506	4	13.3a-g	4	26.7a-j
PI 276842	4	15.0a-g	4	11.7a-g
PI 452681	4	15.0a-g	4	10.0a-g
PI 455586	4	15.0a-g	4	5.3a-e
PI 453253	4	16.7a-h	4	15.0a-h
PI 455626	4	16.7a-h	4	5.7a-f
PI 563094	4	16.7a-h	4	26.7a-j
PI 329799	4	17.0a-h	4	20.0a-j
PI 255963	4	20.0a-i	4	13.3a-h
PI 452683	4	20.0a-i	4	33.3c-k
PI 330870	4	21.7a-i	4	16.7a-i
PI 330874	4	21.7a-i	4	16.7a-i
PI 330875	4	23.3a-j	4	31.7b-j
PI 257598	4	30.0a-k	4	36.7f-l
PI 257596	4	33.3a-l	4	23.3a-j
PI 452684	4	36.7a-m	4	36.7f-l
PI 257595	4	35.0a-l	4\4\5	36.7f-l
PI 257603	4	33.3a-l	4\4\5	36.7f-l
PI 276838	4	56.7i-r	4\4\5	23.3a-j
PI 276840	4	10.3a-e	4\4\5	7.3a-f
PI 276843	4	11.7a-f	4\4\5	9.3a-g
PI 329793	4	15.0a-g	4\4\5	23.3a-j
PI 330794	4	1.3a	4\4\5	2.3a-c
PI 454941	4	4.3a-c	4\4\5	4.3a-e
PI 455548	4	28.3a-k	4\4\5	17.0a-i
PI 455631	4	3.7ab	4\4\5	7.3a-f
PI 257600	4	20.0a-i	4\5\5	33.3c-k
PI 267623	4	10.7a-e	4\5\5	23.5a-j
PI 330819	4	7.3a-d	4\5\5	16.7a-i
PI 455545	4	20.0a-i	5	46.7i-o
PI 454515	4\4\5	10.3a-e	4	8.3a-f
PI 318909	4\4\5	11.8a-f	4	10.3a-g
PI 454990	4\4\5	16.7a-h	4	4.3a-e
PI 457865	4\4\5	31.7a-k	4	18.3a-i
PI 457864	4\4\5	6.8a-d	4\4\5	4.0a-e
PI 454157	4\4\5	20.0a-i	4\5\5	15.0a-h
PI 457863	4\4\5	20.2a-i	4\4\5	7.0a-f
PI 330864	4\4\5	26.7a-k	4\5\5	15.0a-h
PI 305022	4\4\5	36.7a-m	4\4\5	20.0a-j
PI 457866	4\4\5	40.0b-n	4\4\5	21.7a-j
PI 196047	4\4\5	43.3d-o	4\4\5	30.0a-j
PI 455397	4\4\5	50.0g-q	4\4\5	46.7i-o
PI 330876	4\5\5	33.3a-l	4\5\5	5.3a-e
PI 267635	4\5\5	43.3d-o	4\4\5	46.7i-o
PI 305034	4\5\5	45.0e-o	4\5\5	36.7f-l
PI 563098	4\5\5	46.7e-p	4\5\5	20.3a-j
PI 267637	4\5\5	48.3f-p	4\5\5	40.0g-m
PI 267638	4\5\5	50.0g-q	4\5\5	33.3c-k
PI 267624	4\4\5	10.3a-e	5	30.0a-j
PI 276797	4\4\5	28.3a-k	5	50.0j-p
PI 276834	4\5\5	7.0a-d	5	15.0a-h
PI 330765	4\5\5	18.3a-h	5	25.0a-j
PI 585379	4\5\5	26.7a-k	5	11.7a-g
PI 305035	4\5\5	41.7c-n	5	30.0a-j
PI 148094	4\5\5	43.3d-o	5	66.7l-q
PI 305044	4\5\5	43.3d-o	5	50.0j-p
PI 276768	5	46.7e-p	4\5\5	35.0e-k
PI 329476	5	63.3k-r	4\5\5	40.0g-m
PI 330768	5	60.0j-r	4\5\5	63.3k-q
PI 457801	5	70.0l-r	4\5\5	70.0m-q
PI 454164	5	40.0b-n	5	66.7l-q
PI 455396	5	50.0g-q	5	63.3k-q
PI 455768	5	56.7i-r	5	73.3n-q
PI 196891	5	60.0j-r	5	43.3h-n

Table 1: Continued

PI 453252	5	70.0lm-r	5	73.3n-q
PI 454224	5	73.3m-r	5	80.0pq
PI 454574	5	76.7n-r	5	86.7q
PI 455767	5	76.7n-r	5	83.3q
PI 457799	5	76.7n-r	5	70.0m-q
PI 195043	5	80.0o-r	5	83.3q
PI 195044	5	80.0o-r	5	80.0pq
PI 457867	5	80.0o-r	5	90.0q
PI 563092	5	80.0o-r	5	86.7q
PI 563093	5	83.3p-r	5	80.0pq
PI 196054	5	90.0r	5	86.7q
PI 454516	5	90.0r	5	83.3q
PI 454575	5	90.0r	5	83.3q
PI 455546	5	90.0r	5	83.3q
NSL 4025	2	0.0a	2	0.0a
PI 250582	2	0.0a	2	0.0a
PI 533794	2	0.0a	2	0.0a
PI 533909	2	0.0a	2	0.0a
PI 533991	2	0.0a	2	0.0a
PI 534131	2	0.0a	2	0.0a
PI 535792	2	0.0a	2	0.0a
PI 595735	2	0.0a	2	0.0a
PI 533831	4	0.7a	4	2.3a-c
PI 641848	4\4\5	5.3a-c	2\4\4	0.4a
PI 561472	5	23.3a-j	5	15.0a-h
PI 609251	5	50.0g-q	4\4\5	43.3h-n
PI 534157	5	53.3h-r	5	50.0j-p
PI 564163	5	56.7i-r	5	36.7f-l
PI 152714	5	60j-r	5	76.7o-q
PI 533772	5	80opqr	5	73.3n-q
PI 211633	5	86.7qr	5	83.3q
PI 173112	5	90r	5	86.7q

¹Plant introduction numbers [11] for the 180 Ethiopian sorghum accessions, eight resistant control genotypes, NSL 4025 (Redlan), PI 250582, PI 533794 (SC110), PI 533909 (SC48), PI 533991 (SC748), PI 534131 (SC30), PI 535792, PI 595735 (SC1313), and 10 susceptible control genotypes, PI 152714, PI 173112, PI 211633, PI 533772 (SC271), PI 533831 (SC414), PI 534157 (SC170), PI 561472 (Sureño), PI 564163 (BTx623), PI 609251, PI 641848, included in the anthracnose evaluation. Accessions are listed in the table from resistant to susceptible, with the control genotypes list at the end of the table.

²The anthracnose disease rating is based on a 1 to 5 scale [13]. Resistant accessions that showed red spots or reddening of inoculated leaves and no acervuli development were rated as 2. Susceptible accessions were rated as 4 or 5 and showed acervuli development on inoculated leaves and infection spreading to non-inoculated leaves. Plants rated as 5 were highly susceptible and showed acervuli development on most leaves including the flag leaf. The disease rating data for the three replications is presented for accessions that showed variation for infection response across replications.

³Disease severity was based on a visual estimate of the percentage of infected leaf area for the susceptible plants within a row and averaged across the three replications [13]. Numbers followed by the same letter were not significantly different at $P = 0.05$ using Tukey's standardized range test.

Overall, 35 accessions were rated as resistant across the two growing seasons. For the 145 accessions rated as susceptible, 98 showed a susceptible response across replications and growing seasons. Nine accessions rated as susceptible in 2009 showed a resistant response in 2008 and five accessions rated as susceptible in 2008 showed a resistant response in 2009. The majority of the accessions that showed variation in susceptibility across replications in 2008 showed variation across replications in 2009.

Mean infection severity for the susceptible accessions was also similar across growing seasons (Table 1). Mean infection severity was 23.4% for the 136 accessions rated as susceptible in 2008 and 22.6% for the 140 accessions rated as susceptible in 2009. Mean infection severity was generally less than 1% for the accessions that showed variation in susceptibility across replications and growing seasons. Seventeen accessions showed a mean infection

severity greater than 50% for both the 2008 and 2009 evaluations.

The disease rating and infection severity for the 18 control genotypes was as expected (Table 1). The eight resistant control genotypes, NSL 4025, PI 250582, PI 533794, PI 533909, PI 533991, PI 534131, PI 535792, PI 595735, showed red spots or reddening of inoculated leaves within 7 days after inoculation and no acervuli development was observed on leaves during the final evaluation. For the 10 susceptible control genotypes, PI 152714, PI 173112, PI 211633, PI 533772, PI 533831, PI 534157, PI 561472, PI 564163, PI 609251, PI 641848, acervuli development on inoculated leaves was generally observed with 30 days after inoculation with acervuli observed on the flag leaf within 60 days after inoculation for the eight highly susceptible control genotypes. Infection severity was similar across growing seasons for the susceptible control genotypes with a mean infection severity of 50.6% in 2008 and 46.8% in 2009.

DISCUSSION

Approximately 19% of the 180 photoperiod-insensitive sorghum accessions from Ethiopia showed a resistant response to anthracnose across growing seasons in Puerto Rico. This low frequency of anthracnose resistant accessions may not be typical of sorghum germplasm from Ethiopia. Evaluation of photoperiod-sensitive germplasm will be essential to determine the frequency of anthracnose resistance for the Ethiopian collection. Greater susceptibility to anthracnose has been observed for regions of low annual rainfall [14, 15]. Erpelding [15] reported a frequency of resistant germplasm less than 20% for regions of Mali receiving less than 600 mm of annual rainfall. Temperature, relative humidity and length of dew period can also influence susceptibility to anthracnose [16]. For the Ethiopian germplasm subset, passport information was lacking to determine whether the 180 accessions were collected from regions with unfavorable climatic conditions for disease development that may have contributed to the greater anthracnose susceptibility observed for these accessions. The accessions also showed phenotypic diversity and the 35 resistant accessions may also be a source of genetic diversity for anthracnose resistance.

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