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Screening of sorghum varieties against zonate leaf spot of sorghum incited by *Gloeocercospora sorghi*

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Abstract

The sorghum crop is believed to have first been cultivated in Africa, it is grown primarily as a food, feed source, and also as staple food source in many countries, particularly in arid regions of the world. Zonate leaf spot of sorghum occurs throughout the wet sorghum growing regions of the world, it damaged up to 90% of the photosynthetic leaf area under humid and cloudy weather conditions in India. Out of fifty varieties screened, four varieties viz., Pant Chari-2, Pant Chari-3, CSH-40, and PC-121 showed moderate resistance to zonate leaf spot, whereas six varieties CSV-35F, SSU-74, 33MF, SRF-280, PC-1001, and CO(FS)-29 were moderately susceptible. Eighteen varieties Pant Chari-5, UP-Chari-1, UP-Chari-2, Rajasthan local, UTFS-109, UTFS-111, SGL-87, SSG-59-3, SSV-74, Rampur local, CSV-21F, CSV-10, CSV-15, CSV-19SS, CSV-30F, PC-23,HC-171, and HC-260 were susceptible and highly susceptible varieties Pant Chari-1, Pant Chari-4, Pant Chari-6, Pant Chari-7, Pant Chari-8, Pant Chari-9, Pant Chari-11, UP-Chari-14, UPPS(PC-7), MP-Chari, Nizamabad, UTFS-108, UTFS-121, UTFS-122, RS-673, UTM-583, UTM-580, UTM-581, CSV-30MF, UTFS-110, CSV-24SS, and CSV-673. None of the varieties has immune nor completely resistant to *G. sorghi*. Moderately resistant varieties can be recommended for growers to reduce yield loss and also escape residual effects in fodder sorghum.

Keywords: *Gloeocercospora sorghi*, screening, sorghum, zonate

Introduction

The Sorghum (*Sorghum bicolor* L. Moench) crop is the fifth leading cereal, after wheat, rice, maize, and barley in the world. Sorghum is a strong grass and usually grows to a height of 2 to 8.2 feet, sometimes reaching as high as 15.4 feet. Leaves and stalks are coated with white wax, and a central portion of the stalks is sweet and juicy. The leaves are about 1 to 2 inches broad and up to 1.2 meters long. The tiny flowers produced in panicles are loose to dense each flower cluster bears 850–3,050 kernels. The seeds vary in colour, shape, and size. Sorghum crop is believed to have first been cultivated and used as a food in Africa, it is a staple food source in many countries, particularly in arid regions of the world. Sorghum plants have a high tolerance for water shortages, making it possible to grow on soils with relatively low fertility compared to other cereal crops. Sorghum is grown in areas receiving 450 to 1000 mm annual rainfall and the temperature requirement for the growth and development is 26 °C to 35 °C. (Rao *et al.*, 2004) [7]. Sorghum is used for fodder and food, and the production of alcoholic beverages (Reddy *et al.*, 2006) [8]. Sorghum has a nutritional profile similar to rice, corn, and wheat to be a potential staple food and its grains have a very good source of vitamins which are copper iron, potassium selenium, magnesium, phosphorus, and zinc. Sorghum is susceptible to many foliar diseases, among them, fungal origin prevalent in India are zonate leaf spot, rust, anthracnose, downy mildew, leaf blight, sooty stripe, tar spot, and gray leaf spot (Sharma *et al.*, 1978) [9].

Zonate leaf spot of sorghum disease is caused all over the moist sorghum growing part of the world, it was first found as a pathogen of sweet sorghum in Louisiana. Zonate leaf spots on sorghum damaged up to 90% of the photosynthetic leaf area under humid and cloudy weather conditions in India (Anahosur, 1986) [2]. Leaf weight decreased and leaf dry matter content increased with increasing severity of infection. This type of damage affects forage and grain production

Gloeocercospora sorghi (Bain & Edgerton) causes a zonate leaf spot on sorghum, pearl millet, corn, and other grasses (Frederiksen and Odvody, 2000) [4]

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The symptoms occurred in seedlings, leaf sheath, leaf, and peduncle of sorghum and Johnson grass. The first visible symptoms are the appearance of small non-diagnostic lesions on the lower leaves. These lesions may occur anywhere on the leaf as the lesions mature, they become circular or target-shaped on the interior of the leaf and semi-circular on the leaf margins with alternating bands of dark red, tan, purple, or straw colour, giving characteristic concentric zonate appearance depending on the variety (Purohit *et al.*, 2013) [6]. Seedling infection can result in defoliation and death of the plant (Franklin, 2000) [3]. When the weather is favourable the disease progresses covering the whole plant and lesions may occur on all leaves with slimy pink spores on leaves that may be blighted, forming microsclerotia. Microsclerotia is also present on the seed coat and soil. The pathogen overwinters as sclerotia on the infected plant tissues (Odvody and Madden, 1984) [5]. The conidia are disseminated by rain-splash, and sclerotia are the survival propagules and germinate via sporodochial formation or germ tube. No sexual stage is known. In the infected leaf tissue Sclerotia are formed sub-epidermally and released into the soil during leaf decomposition. Zonate leaf spot is more prevalent in warm, humid years and overwinters on crop residue. Disease severity depends on high rainfall, cloudy weather, and high relative humidity. Disease development is favourable at 28-32°C and 90 per cent RH. Seed exudates, root exudates, and

leaf guttations stimulated sclerotial germination. The best method of control is the use of resistant varieties which is economically feasible and has no residual effect. To date, no variety is available that shows resistance against these devastating foliar diseases. The present investigation was done to find out the sources of resistance.

Material and Methods

Screening of sorghum varieties against zonate leaf spot under natural epiphytotic conditions

Fifty sorghum cultivars/varieties were collected and screened at the AICRP Sorghum Centre, G.B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand; during Kharif, 2021 (29.0222°N, 79.4908°E) under natural field conditions. Varieties were sown with two replications (50 × 15 cm). Observation of disease intensity of zonate leaf spot was recorded at 25, 50, and 75 days after germination (DAG) based on a disease severity 1 to 9 scale (Sharma, 1983) [10]. The per cent disease intensity (PDI) was calculated by the following formula.

$$\text{PDI} = \frac{\text{Sum of numerical rating}}{\text{Total number of plants observed} \times \text{Highest disease scale}} \times 100$$

Table 1: Disease Rating scale of Foliar Pathogens

Score	Per cent intensity	Reaction
1	0 to < 1.0	Immune
2	1.1- 5.0	Highly Resistant
3	5.1-10.0	Resistant
4	10.1-20.0	Moderately Resistant
5	20.1-30.0	Moderate Susceptible
6	30.1-40.0	Susceptible
7	40.1-50.0	Susceptible
8	50.1-75.0	Highly Susceptible
9	75.1 and above	Highly Susceptible

Result and Discussion

Table 2: Screening of sorghum varieties against zonate leaf spot in field conditions

S.N	Variety name	Days after sowing			Disease rating
		25	50	75	
1	Pant Chari-1	23.04	62.21	74.86	8
2	Pant Chari-2	2.14	4.26	4.66	2
3	Pant Chari-3	1.58	3.25	4.26	2
4	Pant Chari-4	20.45	49.26	73.25	8
5	Pant Chari-5	9.14	18.25	27.25	5
6	Pant Chari-6	15.14	25.66	39.45	6
7	Pant Chari-7	14.68	30.66	40.25	6
8	Pant Chari-8	17.25	35.92	49.25	7
9	Pant Chari-9	21.15	60.66	74.89	8
10	Pant Chari-11	22.27	50.25	75.00	8
11	UP-Chari-1	9.14	14.26	20.90	4
12	UP-Chari-2	8.45	12.25	16.58	4
13	UP-Chari-14	25.14	53.15	73.89	8
14	UPFS(PC-7)	18.14	36.25	48.25	7
15	MP-Chari	18.49	36.15	50.00	7
16	Rajasthan local	8.14	15.36	20.45	4
17	Nizamabad	14.18	33.25	40.00	6
18	UTFS-108	16.14	34.25	45.25	7
19	UTFS-111	12.25	23.56	29.25	5
20	UTFS-109	8.15	14.25	19.25	4

21	UTFS-121	16.45	35.15	47.86	7
22	UTFS-122	14.25	25.65	38.47	6
23	SGL-87	12.56	23.15	30.24	5
24	SSG-59-3	7.56	14.26	18.25	4
25	RS-673	16.12	24.26	35.48	6
26	SSV-74	10.25	16.25	29.24	5
27	Rampur local	9.25	17.26	27.25	5
28	UTMC-583	18.45	34.15	48.56	7
29	UTMC-580	19.25	38.45	49.25	7
30	UTMC-581	25.45	60.25	87.15	9
31	UTFS-110	29.25	52.36	88.45	9
32	CSV-30MF	19.15	25.45	38.99	6
33	CSV-35F	4.25	6.11	7.79	3
34	CSV-21F	9.12	15.45	27.45	5
35	SSU-74	4.25	6.25	8.78	3
36	CSV-10	12.25	20.45	30.00	5
37	CSV-24SS	17.13	24.26	37.95	6
38	CSV-15	14.26	21.15	29.45	5
39	CSV-673	14.56	26.25	39.12	6
40	CSV-19SS	9.15	13.25	18.25	4
41	CSV-30F	10.15	20.15	25.14	5
42	CSH-40	2.14	4.12	4.66	2
43	33MF	4.26	7.25	9.14	3
44	SRF-280	3.25	5.45	9.24	3
45	PC-23	9.25	14.18	27.45	5
46	PC-121	1.15	3.15	5.14	2
47	PC-1001	4.15	7.15	9.14	3
48	HC-260	7.15	15.45	19.14	4
49	HC-171	6.15	14.14	17.26	4
50	CO(FS)-29	4.25	6.45	9.24	3
Check	Pant Chari-10	26.01	60.45	90.12	9

Table 3: The per cent disease incidence

Disease grade	Disease intensity	Variety name
Immune	No infection	---
Resistance	1-10.1	---
Moderate resistance	10.1-20	Pant Chari-2, Pant Chari-3, CSH-40, PC-121
Moderate susceptible	20.1-30	CSV-35F, SSU-74, 33MF, SRF-280, PC-1001, CO(FS)-29
Susceptible	30.1-50	Pant Chari-5, UP-Chari-1, UP-Chari-2, Rajasthan local, UTFS-109, UTFS-111, SGL-87, SSG-59-3, SSV-74, Rampur local, CSV-21F, CSV-10, CSV-15, CSV-19SS, CSV-30F, PC-23, HC-171, HC-260
Highly susceptible	>50	Pant Chari-1, Pant Chari-4, Pant Chari-6, Pant Chari-7, Pant Chari-8, Pant Chari-9, Pant Chari-11, UP-Chari-14, UPFS(PC-7), MP-Chari, Nizamabad, UTFS-108, UTFS-121, UTFS-122, RS-673, UTMC-583, UTMC-580, UTMC-581, CSV-30MF, UTFS-110, CSV-24SS, CSV-673

Fifty sorghum varieties were screened under field conditions against zonate leaf spot disease during Kharif, 2021. The data on disease intensity was recorded, out of fifty varieties screened four varieties showed moderate resistant reactions which were Pant Chari-2, Pant Chari-3, CSH-40, PC-121 and six varieties were moderately susceptible which were CSV-35F, SSU-74, 33MF, SRF-280, PC-1001, CO(FS)-29. Eighteen varieties were susceptible *viz.* Pant Chari-5, UP-Chari-1, UP-Chari-2, Rajasthan local, UTFS-109, UTFS-111, SGL-87, SSG-59-3, SSV-74, Rampur local, CSV-21F, CSV-10, CSV-15, CSV-19SS, CSV-30F, PC-23, HC-171, HC-260 and remaining twenty-two varieties highly susceptible, which were Pant Chari-1, Pant Chari-4, Pant Chari-6, Pant Chari-7, Pant Chari-8, Pant Chari-9, Pant Chari-11, UP-Chari-14, UPFS(PC-7), MP-Chari, Nizamabad, UTFS-108, UTFS-121, UTFS-122, RS-673, UTMC-583, UTMC-580, UTMC-581,

CSV-30MF, UTFS-110, CSV-24SS, CSV-673. No variety non-immune or resistant to *G. sorghi*. All the infected lesions produced spores and lesions containing numerous sclerotia bodies. UTMC-581 and UTFS-110 varieties have more than a ninety per cent leaf area covered with zonate leaf spots and leaves appeared as blighted and wilted. The symptoms are clearer in purple-type varieties than in tan varieties.

Conclusion

Out of fifty varieties, only four were moderately resistant, six moderately susceptible, eighteen susceptible, and twenty-two highly susceptible. No sorghum variety was resistant or immune to the zonate leaf spot of sorghum. Varieties UTMC-581 and UTFS-110 appeared as blighted and wilted with more than ninety per cent leaf area covered with zonate leaf spots. Therefore, breeding for zonate leaf spot-resistant varieties is paramount for the effective management of zonate leaf spots

of sorghum. Identification of resistant sources may be used in breeding for different resistance against zonate leaf spots of sorghum.

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