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Research Article

SCREENING OF PEARL-MILLET GERMPLASMS FOR RESISTANCE AGAINST *SCLEROSPORA GRAMINICOLA* CAUSING DOWNEY MILDEW

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Abstract: The total of 115 germplasm of pearl millet were screened against the highly susceptible check 7042S in sick fields. Among one hundred fifteen entries, three entries *viz*., MH 2466, MH 2504 and Dhanshati were expressed highly resistant (0-5%) reaction against downy mildew disease with the lowest per cent disease incidence; while, the sixty seven entries showed resistant (5.1-10%) reaction *viz*., MH 2458, MH 2459, MH 2460, MH 2461, MH 2462, MH 2463, MH 2467, MH 2468, MH 2470, MH 2472, MH 2473, MH 2474, MH 2477, MH 2480, MH 2481, MH 2482, MH 2483, MH 2484, MH 2485, MH 2486, MH 2489, MH 2491, MH 2493, MH 2494, MH 2495, MH 2498, MH 2500, MH 2503, MH 2505, MH 2506, MH 2512, MH 2513, MH 2517, MH 2518, MH 2519, MH 2520, MH 2521, MH 2523, MH 2525, MH 2526, MH 2528, MH 2529, MH 2530, MH 2531, MH 2533, MH 2535, MH 2539, MH 2540, MH 2541, MH 2542, MP 596, MP 599, MP 600, RHB 177, HHB 67 Improved, HHB 272, MPMH 17, 86M01, PB 1705, KBH 108, MP-7792, Kaveri S. Boss, NBH 4903, ICMV 221, Pusa Comp. 383, Pusa Comp. 701 and Pusa Comp. 612. Forty five entries exhibited moderately resistant (10.1-20%) reaction *viz*., MH 2457, MH 2464, MH 2465, MH 2469, MH 2471, MH 2475, MH 2476, MH 2478, MH 2479, MH 2487, MH 2488, MH 2490, MH 2492, MH 2496, MH 2497, MH 2499, MH 2501, MH 2502, MH 2507, MH 2508, MH 2509, MH 2510, MH 2511, MH 2514, MH 2515, MH 2516, MH 2522, MH 2524, MH 2527, MH 2532, MH 2534, MH 2536, MH 2537, MH 2538, MP 595, MP 597, MP 598, MPMH 21, PRATAP, NBH 5767, 86M86, Raj 171, JBV 2, ICMV 155 and ABV 04. The susceptible check (7042 S and Nokha Local) showed above 90 per cent downy mildew incidence at the location. None of the entries were found susceptible and highly susceptible to *Sclerospora graminicola* downy mildew.

Keywords: *Pearl millet, Sclerospora graminicola, Screening*

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Introduction

Pearl millet (*Pennisetum glaucum*) is a staple food for millions of poor people living in the semi-arid tropical regions of Africa and Asia [1]. India is the largest country in Asia in terms of production and area. It has an area of 7.57 m ha with a production of 10.8 MT and productivity of 1436 kg/ha [2]. Rajasthan, Gujarat, Maharashtra and Uttar Pradesh are the major pearl millet growing states of India. Rajasthan is the leading state with an area of 4.31 m ha with a production of 5.77 MT and productivity of 1337 kg/ha [3]. Major bajra producing areas in Rajasthan are Barmer, Jodhpur, Nagaur, Bikaner, Churu, Ganganagar, SawaiMadhopur, Alwar, Kota, Tonk, Jhunjhunu, Pali and Jaisalmer.

Pearl millet is attacked by many diseases however; economically important diseases include downy mildew, blast, rust, ergot and smut. There are so many diseases affecting pearl millet production among them Downy mildew [*Sclerospora graminicola*, (Sacc).Schroet] is a serious threat in most pearl millet growing areas of Asia and Africa. Downy mildew of pearl millet was first reported by Butler, (1907) [4] in India and described it the disease of ill-drained lands where it developed into epidemics of severity. The first symptoms of the disease were noticed in two weeks old seedling as chlorotic strips on the upper surface of the leaves which progresses from based to top, some produces malformed earhead (green ear). Structural variations have been observed in green ears.

In 1971, popular hybrid HB 3 due to the disease appeared in an epidemic form in the Indian sub-continent which had contributed to a record harvest of 8 million. In 1970-71[5]. Subsequent to this epidemic, grain yield losses continued to occur quite frequently due to downy mildew epidemics in India [6].

Williams *et al*., (1981) [7] developed improved field screening technique for downy mildew resistance in pearl millet which is followed all over the world. Singh *et al*., (1990) [8] have registered five germplasm with stable resistance to downy mildew in crop science society of America. In the present study and attempt was made to screen 100 selected high yielding pearl millet genotypes against downy mildew as per the procedure suggested by William *et al.,* (1981) [7] and Singh & Gopinath (1975) [9] evaluation of genotype was done at 30 days at dough stage at sick plot.

Materials and Methods

Screening for resistance to downy mildew a total of 115 pearl millet entries were procured from ICAR- All India Coordinated Research Project on pearl millet, Section of Genetics and Plant Breeding Agricultural University, Jodhpur. These entries were evaluated against downy mildew using field screening technique William *et al.,* (1981) [7] under sick experimental field at research farm, ICAR-AICRP on Pearl millet, Mandor, Jodhpur during Kharif 2019-20. For this purpose, a highly susceptible cultivar 7042S was used as infector row and sown three weeks before the test material. At the time of sowing, a fine powder of oosporic material was added to the furrows. Between every two infector rows five lines of five meter each, test entries were sown. Two replications were maintained for each test entry. The pearl millet downy mildew incidence was recorded twice *viz*., first at 30 days and second at 60 days after sowing by formula mentioned below and the reaction of varieties were categorized as given in [Table-1].

Per cent disease incidence = [Number of infected plant /Total number of plant] X 100

Table-1 Screening of entries were categorized for disease assessment as follows.

Disease rating	Incidence (%)	Disease reaction
1	0-5	Highly Resistant (HR)
2	5.1-10	Resistant (R)
3	10.1-20	Moderately Resistant (MR)
4	20.1-50	Susceptible (S)
5	>50	Highly Susceptible (HS)

Table-2 Evaluation of pearl millet entries against downy mildew under sick field conditions during kharif-2019-20.

Germplasms	Disease incidence (%)		Disease reaction
	30 DAS	60 DAS	
MH 2457	5.00 (8.13)	11.25 (12.22)	MR
MH 2458	3.41 (6.93)	7.95 (10.75)	R
MH 2459	6.10 (9.05)	9.76 (11.44)	R
MH 2460	3.57 (6.93)	8.33 (10.75)	R
MH 2461	3.49 (6.93)	6.98 (9.97)	R
MH 2462	5.75 (9.05)	6.90 (9.83)	R
MH 2463	3.45 (6.93)	8.05 (10.75)	R
MH 2464	7.46 (9.05)	10.45 (10.75)	MR
MH 2465	4.65 (8.13)	10.47 (12.22)	MR
MH 2466	0.00 (0.00)	2.63 (5.74)	HR
MH 2467	1.28 (2.87)	5.13 (8.13)	R
MH 2468	3.85 (6.93)	6.41 (9.05)	R
MH 2469	5.06 (8.13)	11.39 (12.22)	MR
MH 2470	2.47 (5.74)	6.17 (9.05)	R
MH 2471	6.85 (9.05)	10.96 (11.53)	MR
MH 2472	4.82 (8.13)	8.43 (10.75)	R
MH 2473	5.43 (9.05)	8.70 (11.44)	R
MH 2474	4.21 (8.13)	6.32 (9.83)	R
MH 2475	5.88 (8.64)	10.59 (12.22)	MR
MH 2476	6.67 (9.05)	10.67 (11.44)	MR
MH 2477	7.14 (9.05)	10.00 (10.75)	R
MH 2478	7.32 (9.83)	10.98 (12.22)	MR
MH 2479	6.02 (9.05)	10.84 (12.07)	MR
MH 2480	3.49 (6.93)	5.81 (9.05)	R
MH 2481	6.25 (9.05)	8.75 (10.75)	R
MH 2482	5.13 (8.13)	8.97 (10.75)	R
MH 2483	3.75 (6.93)	8.75 (10.75)	R
MH 2484	4.17 (6.93)	6.94 (9.05)	R
MH 2485	2.53 (5.74)	7.59 (9.83)	R
MH 2486	6.94 (9.05)	9.72 (10.75)	R
MH 2487	3.45 (5.74)	10.34 (9.97)	MR
MH 2488	5.95 (9.05)	10.71 (12.22)	MR
MH 2489	7.69 (9.05)	9.23 (9.83)	R
MH 2490	4.05 (6.93)	10.81 (11.44)	MR
MH 2491	5.71 (8.13)	10.00 (10.75)	R
MH 2492	7.50 (9.83)	12.50 (12.85)	MR
MH 2493	4.82 (7.85)	8.43 (10.75)	R
MH 2494	5.13 (8.13)	7.69 (9.83)	R
MH 2495	5.56 (9.05)	8.89 (11.44)	R
MH 2496	4.76 (6.93)	11.11 (10.75)	MR
MH 2497	8.82 (9.83)	14.71 (12.85)	MR
MH 2498	6.02 (9.05)	8.43 (10.75)	R
MH 2499	6.67 (9.05)	10.67 (11.44)	MR
MH 2500	3.41 (6.93)	6.82 (9.83)	R
MH 2501	7.27 (8.13)	14.55 (11.44)	MR
MH 2502	5.26 (6.93)	10.53 (9.83)	MR
MH 2503	4.88 (8.13)	9.76 (11.53)	R
MH 2504	2.22 (5.74)	4.44 (8.13)	HR
MH 2505	3.75 (6.93)	6.25 (9.05)	R
MH 2506	8.33 (9.05)	10.00 (9.83)	R
MH 2507	8.77 (9.05)	15.79 (12.22)	MR
MH 2508	9.52 (9.83)	14.29 (12.07)	MR
MH 2509	7.14 (8.13)	14.29 (11.53)	MR
MH 2510	6.49 (9.05)	10.39 (11.44)	MR
MH 2511	7.23 (9.83)	12.05 (12.85)	MR
MH 2512	2.44 (5.74)	6.10 (9.05)	R
MH 2513	3.33 (6.93)	5.56 (9.05)	R
MH 2514	8.20 (9.05)	11.48 (10.75)	MR
MH 2515	6.85 (9.05)	10.96 (11.44)	MR
MH 2516	8.22 (9.97)	12.33 (12.22)	MR
MH 2517	5.00 (7.85)	7.50 (9.83)	R
MH 2518	6.90 (9.83)	6.90 (9.97)	R
MH 2519	6.25 (9.05)	10.00 (11.15)	R
MH 2520	6.25 (9.05)	8.75 (10.75)	R
MH 2521	6.49 (8.64)	6.49 (9.05)	R
MH 2522	4.60 (7.85)	10.34 (12.22)	MR
MH 2523	5.48 (8.13)	8.22 (9.83)	R
MH 2524	11.11 (10.75)	12.70 (11.44)	MR
MH 2525	5.00 (8.13)	6.25 (9.05)	R
MH 2526	7.04 (9.05)	9.86 (10.75)	R
MH 2527	5.26 (6.93)	12.28 (10.75)	MR
MH 2528	8.64 (10.75)	7.41 (9.83)	R
MH 2529	8.11 (9.83)	9.46 (10.75)	R
MH 2530	3.70 (6.93)	8.64 (10.52)	R
MH 2531	7.79 (9.97)	7.79 (9.83)	R
MH 2532	6.56 (8.13)	11.48 (10.75)	MR
MH 2533	6.41 (9.05)	8.97 (10.75)	R
MH 2534	10.29 (10.75)	11.76 (11.44)	MR
MH 2535	7.32 (9.83)	7.32 (9.83)	R
MH 2536	5.45 (6.93)	10.91 (9.97)	MR
MH 2537	5.80 (7.85)	10.14 (10.52)	MR
MH 2538	5.97 (8.13)	10.45 (10.75)	MR
MH 2539	2.56 (5.74)	8.97 (10.52)	R
MH 2540	5.17 (6.93)	8.62 (8.64)	R
MH 2541	5.71 (7.85)	7.14 (9.05)	R
MH 2542	4.05 (6.93)	8.11 (9.83)	R
MP 595	4.41 (6.93)	13.24 (12.07)	MR
MP 596	6.41 (9.05)	7.69 (9.83)	R
MP 597	6.67 (9.05)	10.67 (11.44)	MR
MP 598	12.50 (10.75)	17.86 (12.85)	MR
MP 599	4.92 (6.93)	8.20 (9.05)	R
MP 600	4.35 (6.93)	5.80 (7.85)	R
RHB 177	2.35 (5.74)	7.06 (9.83)	R
HHB 67 Improved	3.45 (6.93)	5.75 (9.05)	R
MPMH 21	5.88 (7.85)	10.29 (10.52)	MR
HHB 272	2.53 (5.74)	7.59 (9.83)	R
MPMH 17	3.75 (6.93)	7.50 (9.97)	R
86M01	6.41 (9.05)	7.69 (9.83)	R
PB 1705	7.50 (9.83)	10.00 (11.44)	R
PRATAP	7.25 (9.05)	10.14 (10.75)	MR
NBH 5767	7.46 (9.05)	10.45 (10.75)	MR
KBH 108	4.11 (6.93)	9.59 (10.75)	R
86M86	10.34 (9.83)	10.34 (9.83)	MR
MP-7792	5.33 (7.85)	9.33 (10.75)	R
Kaveri S. Boss	4.82 (8.13)	8.43 (10.75)	R
NBH 4903	6.38 (9.83)	8.51 (11.44)	R
Raj 171	7.84 (7.85)	11.76 (9.83)	MR
ICMV 221	6.94 (9.05)	6.94 (9.05)	R
Pusa Comp. 383	7.14 (9.83)	8.33 (10.75)	R
JBV 2	6.41 (8.64)	11.54 (12.22)	MR
Dhanshakti	4.00 (6.93)	4.00 (6.93)	HR
Pusa Comp. 701	4.88 (7.85)	6.10 (9.05)	R
ICMV 155	7.55 (8.13)	11.32 (9.97)	MR
Pusa Comp. 612	4.11 (6.93)	6.85 (9.05)	R
ABV 04	11.29 (10.75)	14.52 (12.22)	MR
7042S (check)	73.08 (32.52)	93.25 (31.92)	HS
Nokha local (check)	71.34 (29.22)	93.15 (34.40)	HS
C.D.	3.88	3.07	
SE(m)	1.38	1.10	
SE(d)	1.96	1.55	
C.V.	22.97	14.22	

Results and Discussion

In the present study following symptoms of downy mildew were recorded on the downy mildew susceptible pearl millet hybrids and varieties planted in the downy mildew sick experimental field. A total of 115 pearl millet lines were evaluated in downy mildew sick field under infector rows systems to identify the downy mildew resistance lines. The downy mildew cultivars "7042S" and local susceptible were also planted in between the test lines to measure the progress of downy mildew. It is obvious from the data presented in[Table-2], that out of 115 entries, 3 lines *viz*., MH 2466, MH 2504 and Dhanshati were expressed highly resistant (0-5%) reaction against downy mildew disease with the lowest per cent disease incidence; respectively while, the sixty seven entries showed resistant (5.1-10%) reaction *viz*., MH 2458, MH 2459, MH 2460, MH 2461, MH 2462, MH 2463, MH 2467, MH 2468, MH 2470, MH 2472, MH 2473, MH 2474, MH 2477, MH 2480, MH 2481, MH 2482, MH 2483, MH 2484, MH 2485, MH 2486, MH 2489, MH 2491, MH 2493, MH 2494, MH 2495, MH 2498, MH 2500, MH 2503, MH 2505, MH 2506, MH 2512, MH 2513, MH 2517, MH 2518, MH 2519, MH 2520, MH 2521, MH 2523, MH 2525, MH 2526, MH 2528, MH 2529, MH 2530, MH 2531, MH 2533, MH 2535, MH 2539, MH 2540, MH 2541, MH 2542, MP 596, MP 599, MP 600, RHB 177, HHB 67 Improved, HHB 272, MPMH 17, 86M01, PB 1705, KBH 108, MP-7792, Kaveri S. Boss, NBH 4903, ICMV 221, Pusa Comp. 383, Pusa Comp. 701 and Pusa Comp. 612. Forty five entries exhibited moderately resistant (10.1-20%) reaction *viz*., MH 2457, MH 2464, MH 2465, MH 2469, MH 2471, MH 2475, MH 2476, MH 2478, MH 2479, MH 2487, MH 2488, MH 2490, MH 2492, MH 2496, MH 2497, MH 2499, MH 2501, MH 2502, MH 2507, MH 2508, MH 2509, MH 2510, MH 2511, MH 2514, MH 2515, MH 2516, MH 2522, MH 2524, MH 2527, MH 2532, MH 2534, MH 2536, MH 2537, MH 2538, MP 595, MP 597, MP 598, MPMH 21, PRATAP, NBH 5767, 86M86, Raj 171, JBV 2, ICMV 155 and ABV 04. The susceptible check (7042 S and Nokha Local) showed above 93.25 & 93.15 per cent downy mildew incidence at the location. None of the entries were found susceptible and highly susceptible to *Sclerospora graminicola* downy mildew. All the tested lines were significantly superior over "7042S". Under *Sclerospora graminicola* sick field condition, the disease shows severe symptoms on highly susceptible cultivars (7042S), in that most of the infected plants were dried and died prematurely. Similarly, Shivkumar *et al*., (2003) [10], Thakur *et al*., (2004) [11], Sharma *et al*., (2007) [12], Latake *et al*., (2008) [13] and Ati *et al*., (2013) [14] evaluated 147 germplasm lines for their resistance and found that, 25 were highly resistant and amongst them, 10 lines were completely free from downy mildew, 32 were resistant, 52 were susceptible and 38 were highly susceptible to downy mildew infection at both 30 and 60 days after planting. Rajput *et al*. (2013) evaluated twenty-two locally cultivated hybrids/varieties, among these seven entries were completely free from downy mildew at 30 days after sowing. Out of these seven, four entries remained free at 60 days after sowing also while four entries showed more than 10 per cent downy mildew incidence at 60 days after sowing. Rajni Singh Sasode *et al*., 2017 [15] screened 100 pearl millet genotypes for resistance to downy mildew and found that, 35 remained free from downy mildew at 60 days after sowing, while 96.87 per cent disease incidence was recorded in 7042S. All the tested lines were significantly superior over ‘‘7042S’’. More than 10 per cent downy mildew was recorded in four lines *viz*., ICMB 92777, BRBL 4, JMSB 20143, 7042R at 60 days after sowing. KK Saini *et al*., 2022 [16] evaluated 62 germplasm lines for their resistance and found that, 36 were highly resistant, 7 lines were resistant to downy mildew, 14 were moderately resistant and 5 were susceptible to downy mildew infection.

Conclusion

Out of 115 pearl millet lines, three entries were expressed highly resistant (0-5%) reaction against downy mildew while, the sixty-seven entries showed resistant (5.1-10%) reaction. 45 entries exhibited moderately resistant (10.1-20%) to downy mildew disease. None of the entry was found susceptible & highly susceptible.

Application of research: To management of downy mildew of pearl millet resistant superiority may be useful genetic resources for improvement of pearl millet. In addition, three entries were expressed highly resistant reaction which can be used for pearl millet production at downy mildew prone area.

Table-3 Reaction of pearl millet entries against downy mildew under sick field conditions

Disease rating	Incidence (%)	Disease reaction	Entries	Total
1	0-5	Highly Resistant (HR)	MH 2466, MH 2504, Dhanshati	3
2	5.1-10	Resistant (R)	MH 2458, MH 2459, MH 2460, MH 2461, MH 2462, MH 2463, MH 2467, MH 2468, MH 2470, MH 2472, MH 2473, MH 2474, MH 2477, MH 2480, MH 2481, MH 2482, MH 2483, MH 2484, MH 2485, MH 2486, MH 2489, MH 2491, MH 2493, MH 2494, MH 2495, MH 2498, MH 2500, MH 2503, MH 2505, MH 2506, MH 2512, MH 2513, MH 2517, MH 2518, MH 2519, MH 2520, MH 2521, MH 2523, MH 2525, MH 2526, MH 2528, MH 2529, MH 2530, MH 2531, MH 2533, MH 2535, MH 2539, MH 2540, MH 2541, MH 2542, MP 596, MP 599, MP 600, RHB 177, HHB 67 Improved, HHB 272, MPMH 17, 86M01, PB 1705, KBH 108, MP-7792, Kaveri S. Boss, NBH 4903, ICMV 221, Pusa Comp. 383, Pusa Comp. 701, Pusa Comp. 612	67
3	10.1-20	Moderately Resistant (MR)	MH 2457, MH 2464, MH 2465, MH 2469, MH 2471, MH 2475, MH 2476, MH 2478, MH 2479, MH 2487, MH 2488, MH 2490, MH 2492, MH 2496, MH 2497, MH 2499, MH 2501, MH 2502, MH 2507, MH 2508, MH 2509, MH 2510, MH 2511, MH 2514, MH 2515, MH 2516, MH 2522, MH 2524, MH 2527, MH 2532, MH 2534, MH 2536, MH 2537, MH 2538, MP 595, MP 597, MP 598, MPMH 21, PRATAP, NBH 5767, 86M86, Raj 171, JBV 2, ICMV 155, ABV 04	45
4	20.1-50	Susceptible (S)	None	0
5	>50	Highly Susceptible (HS)	None	0

Research Category: Plant Pathology

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Study area / Sample Collection: Research farm, ICAR-AICRP on Pearl millet, Mandor, Jodhpur

Cultivar / Variety / Breed name: 115 germplasm of pearl millet

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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