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Screening of *Pearl millet* lines against smut under artificial inoculation

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Abstract
Smut [(*Tolyposporium penicillariae*) Bref.] is one of the important biotic constraint in obtaining the optimum grain yield of many lines of *Pearl millet* in northern region of Madhya-Pradesh. Hundred lines of *Pearl millet* were evaluated under artificial inoculation at research found of college of agriculture, Gwalior during 2021-22 and 2022-23. During 2021-22 two cultivars J-2616 and DHLB 36 B were found completely free from smut, while the maximum smut severity (60.50%) was recorded in IP 17396-4-1-1. In 2022-23 six cultivars *viz.*, TG 4, J-2616, ICMR 11666 and HP-B-502 were found free from smut, while its maximum severity was recorded in IP 17396-4-1-1 (60.00%). On the basis of two years mean data, only one cultivar J-2616 were found absolutely free from smut under artificial inoculation and these two cultivars were significantly superior over most of the tested cultivars except HP-B-502 and DHLB 36 B, while the maximum mean smut severity per cent was recorded in IP 17396-4-1-1 (60.25%).

Keywords: *Pearl millet*, smut, smuts severity, resistant.

Introduction
Pearl millet [*Pennisetum glaucum* (L.) R. Br.] Is one of the important cereal crop subsequent to rice, wheat, maize and sorghum. It is staple food for millions of people and widely grown in about 30 million ha in the arid and semi-arid tropical regions of Africa (>18 million ha) and Asia (>10 million ha) accounting for half of the global millet production. In India, *Pearl millet* is the fourth most widely cultivated food crop after rice, wheat and maize. It is used as a staple food for human consumption, as fodder and feed in livestock sector. It is also used in industries such as alcohol and fuel, starch and processed food sectors. Its grains are most commonly used in the form of chapattis and roti, as bhakri baked over a hot fire, *Pearl millet* grains are also consumed after roasting them in hot sand. Other preparation include frying in deep fat and mixing with pulses, other cereals, crude sugar, butter milk, vegetable, spices, *etc*. Being a climate-resilient crop, *Pearl millet* is very important in mitigating the adverse effects of climate change facilitating income and food security among farming communities of arid regions.
The crop is affected by number of diseases such as blast, downy mildew, smut, rust, and ergot *etc.* (Rachie and Majmudar, 1980) [6]. Smut caused by *Tolyposporium penicillariae* (Bref.) has become one of the major biotic constraints in the cultivation of many *Pearl millet* lines, in many parts of the county including northern resign of Madhya Pradesh. Therefore in the present study a set of hundred lines were evaluated against smut under artificial inoculation during *kharif* 2021 and 2022.

Methodology
A field experiment consisting of hundred lines of *Pearl millet* were evaluated against smut under artificial inoculation at research farm of college of agriculture, Gwalior during two consecutive *kharif* season i.e. during 2021 and 2022. The above experiment was conducted in randomized block design (RBD) having 4 m single row length with two replications. Five plants of each entry per replication were artificial inoculated with sporidial suspension of *Tolyposporium penicillariae* at boot leaf stage followed by covering the inoculated boot with labelled parchment selfing bag to create the humidity inside the bag which is required for smut

infection. After twenty days of inoculation the bags were removed and the smut severity was recorded by using the smut severity rating scale 0-100% assessment key as suggested by Thakur and King (1988a) [10].

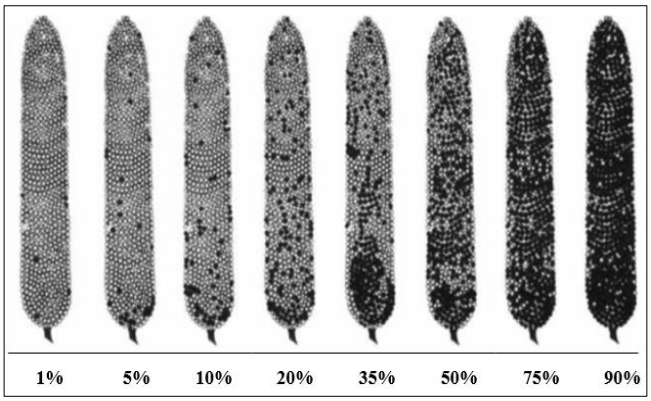

Fig 1: Smut severity rating scale

Results and Discussion

A total of 100 genotypes of were evaluated against smut under artificial inoculation, the data are summarized in the Table 4.9, which reveals that the tested entries showed a great variation in response to smut as their smut severity ranged from 0.00 to 60.25%.

During *Kharif* 2021, two entries J-2616 and DHLB 36 B were absolutely free from the disease. In respect of smut reaction, these two entries were significantly superior over the rest of the 96 entries but statistically at par with HP-B-467(2.50%) and ICMR 101031 (2.50%). Twenty one entries *viz*., IP5719-3, IP 8418-3, IP 18295, YG 8, TG 8, ICMB 17333, ICMB 101840 IP 7876, ICMR 11555, HP-B-458, HP-B-460, HP-B-465, HP-B-502, ICMB 97222, 101-SB-21, JMSB 20158, JMSB 20191, HR-21-9,DHLB 30B and DHLBI 1825 were found under the resistant category because their smut severity was in the range of 2.75-10.00%. Fifty nine *viz*., P 7-4, 834 B, IP 18292, IP 9645, IP 11930, IP 6193-2, IP 14522-1, IP 20715-1, IP 8707-1, IP 8418-3, IP 12374-1, IP 12374-2, IP 20715-2, IP 21201-2, IP 18298, IP 9997, IP 11428, ICMB 101838, ICMB 101793, ICMR 100166, J-2571, J-2595, J-2609, J-2612, J-2619, J-2634, JMSB 20156, 203-BCS-21, HB-21-1, HB-21-2, HB-21-3, HB-21-4, HB-21-5, IP 20715-1-1-5, ICMR 08222, ICMR 08111, ICMR 10888, ICMR 06666, ICMR 08333, ICMR 10999, ICMR 11222, HP-B-460, HP-B-488, HP-B-489, ICMR 11019, ICMR 11009, IP 21187-P1, ICMR 06444, MDMRRC S1-1-136-1-2-1-B, 100-SB-21, HR-21-6, HR-21-7, HR-21-8, HR-21-10, DHLBI 1825, DHLBI 1822, RVBH 1839, RVBH 1840, RVBH 1844, and JBV-2 were categorized as moderately susceptible as their smut severity was in the range of 11.00 to 25.00%. Fifteen entries *viz*., ICMR 10888, ICMR 11222, ICMR 11019, IP 17396-3, IP 17396-4, JMSB 20172, ICMB 01333, IP 8863-1-1, IP 12374-1-1-2, ICMR 12777, ICMR 08444, ICMR 12666, DHLBI 1806 and RVBH 1838 showed susceptible reactions (25.1-50%) while one entry was found in the category of highly susceptible IP 17396-4-1-1 (60.50%).

During *Kharif* 2022, two entries J-2616 and HP-B-502 were absolutely free from the disease. In respect of smut reaction, these two entries were significantly superior over the rest of the 93 entries but statistically at par with 834 B (2.50%), IP 12374-1(2.50%) HP-B-458(1.00%), JMSB 20191(2.50%) and DHLB 36 B (1.50%). Thirty-three entries *viz*., IP 18293, IP 18294, IP 5719-3, IP 14522-1, IP 20715-2, IP 18295, YG 8, TG 8, IP 9997, ZG 3, ICMB 17333, ICMB 101840, ICMR 101031, 203-BCS-21, HB-21-4, IP 7846, IP20715-1-1-5, ICMR 10888, ICMR 06666, ICMR 08333, ICMR 11555, HP-B-465, HP-B-467, ICMR 11003, ICMR 06444, ICMB 97222,100-SB-21, 101-SB-21, JMSB 20158, JMSB 20171, HR-21-9, HR-21-10 and DHLB 30 B were found under the resistant category because their smut severity was in the range of 2.75-10.00%. Forty six entries *viz*., P 7-4, IP 18292, IP 11930, IP 6193-2, IP 14522-1, IP 8707-1, IP 8418-3, IP 12374-2, IP 21201-2, IP 18298, IP 11428, ICMB 101838, ICMB 101793, ICMR 100166, J-2571, J-2595, J-2609, J-2612, J-2619, J-2634, JMSB 20156, HB-21-1, HB-21-2, HB-21-5, ICMB 01333, ICMR 08222, ICMR 08111, ICMR 10999, ICMR 11222, ICMR 12666, HP-B-460, HP-B-488, HP-B-489, ICMR 11019, IP 21187-P1, MDMRRC S1-1-136-1-2-1-B, HR-21-7, HR-21-8, DHLBI 1825, DHLBI 1822, RVBH 1839, RVBH 1840, RVBH 1844 and JBV-2 were categorized as moderately susceptible as their smut severity was in the range of 10.10 to 25.00%. Thirteen entries *viz*., IP 9645, IP 20715-1, IP 17396-3, IP 17396-4, JMSB 20172, ICMB 01333, IP 8863-1-1, IP 12374-1-1-2, ICMR 12777, ICMR 08444, ICMR 11009, DHLBI 1806 and RVBH 1838 showed susceptible reactions (25.1-50%) while one entries was found in the category of highly susceptible IP 17396-4-1-1 (60.00%).

The two years of mean data summarized in the Table 4.9 reveals that one entry J-2616, were found absolutely free from smut. In respect of smut reaction, this one entry were significantly superior over the rest of the ninety seven entries but statistically at par with HP-B-502 (2.50%) and DHLB 36 B (0.75%). Eighty five entries *viz*., 834 B, IP 18293, IP 18294, IP 5719-3, IP 18295, YG 8, TG 4, TG 8, ZG 3, ICMB 17333, ICMB 101840, ICMR 101031, IP 7846, ICMR 11666, ICMR 11555, HP-B-458, HP-B-465, HP-B-467, HP-B-502, ICMR 11003, ICMB 97222, 101-SB-21, JMSB 20158, JMSB 20171, JMSB 20191, HR-21-9, DHLB 30 B, DHLB 36 B, P 7-4, IP 18292, IP 9645, IP 11930, IP 6193-2, IP 14522-1, IP 20715-1, IP 8707-1, IP 8418-3, IP 12374-1, IP 12374-2, IP 20715-2, IP 21201-2, IP 18298, IP 9997, IP 11428, ICMB 101838, ICMB 101793, ICMR 100166, J-2571, J-2595, J-2609, J-2612, J-2619, J-2634, JMSB 20156, 203-BCS-21, HB-21-1, HB-21-2, HB-21-3, HB-21-4, HB-21-5, IP 20715-1-1-5, ICMR 08222, ICMR 08111, ICMR 10888, ICMR 06666, ICMR 08333, ICMR 10999, ICMR 11222, HP-B-460, HP-B-488, HP-B-489, ICMR 11019, ICMR 11009, IP 21187-P1, ICMR 06444, MDMRRC S1-1-136-1-2-1-B, 100-SB-21, HR-21-6, HR-21-7, HR-21-8, HR-21-10, DHLBI 1825, DHLBI 1822, RVBH 1839, RVBH 1840, RVBH 1844, and JBV-2 were shown to have a resistant reaction against smut because their smut severity range was 10.00 to 25.00%. Eleven entries *viz*., IP 17396-3, IP 17396-4, JMSB 20172, ICMB 01333, IP 8863-1-1, IP 12374-1-1-2, ICMR 12777, ICMR 08444, ICMR 12666, DHLBI 1806 and RVBH 1838, were categorized as susceptible because their smut severity range was 25.10 to 50.00%. Only one entry IP 17396-4-1-1 were showed highly susceptible reactions because their smut severity 60.00%. Similar results were obtained by Choursia (2007) [1] evaluated 138 varieties and found that only one entry MH1317 was free from smut and nineteen entries had 5.1-10.0 per cent smut severity.

Table 1: Comparative performance of *Pearl millet* lines against smut under artificial inoculation.

S.N.	Entry	Smut Severity (%)		
		2021	2022	Mean
1	P 7-4	16.25(23.77)	21.50(27.62)	18.88(25.75)
2	834 B	17.50(24.73)	2.50(9.10)	10.00(18.43)
3	IP 18292	17.92(25.04)	22.5(28.32)	20.21(26.71)
4	IP 18293	14.00(21.97)	5.00(12.92)	9.50(17.95)
5	IP 18294	11.67(19.97)	7.50(15.89)	9.58(18.03)
6	IP 9645	13.75(21.77)	27.50(31.63)	20.63(27.01)
7	IP 11930	17.38(24.64)	12.50(20.7)	14.94(22.74)
8	IP 5719-3	10.00(18.43)	5.00(12.92)	7.50(15.89)
9	IP 6193-2	20.00(26.57)	25.00(30)	22.50(28.32)
10	IP 14522-1	12.50(20.7)	9.00(17.46)	10.75(19.14)
11	IP 20715-1	22.50(28.32)	27.50(31.63)	25.00(30.00)
12	IP 8707-1	17.50(24.73)	13.75(21.77)	15.63(23.28)
13	IP 8418-3	10.00(18.43)	20.00(26.57)	15.00(22.79)
14	IP 12374-1	22.50(28.32)	2.50(9.1)	12.5(20.70)
15	IP 12374-2	19.17(25.96)	12.50(20.7)	15.83(23.45)
16	IP 17396-3	18.00(25.1)	42.50(40.69)	30.25(33.37)
17	IP 17396-4	32.50(34.76)	26.25(30.82)	29.38(32.82)
18	IP 20715-2	12.08(20.34)	10.00(18.43)	11.04(19.41)
19	IP 21201-2	20.00(26.57)	18.75(25.66)	19.38(26.11)
20	IP 18295	10.00(18.43)	6.50(14.77)	8.25(16.69)
21	IP 18298	15.00(22.79)	25.00(30.00)	20.00(26.57)
22	YG 8	7.50(15.89)	5.00(12.92)	6.25(14.48)
23	TG 4	12.50(20.7)	0.00(0.00)	6.25(14.48)
24	TG 8	8.08(16.51)	9.75(18.19)	8.92(17.37)
25	IP 9997	32.50(34.76)	7.50(15.89)	20.00(26.57)
26	IP 11428	24.90(29.93)	20.25(26.74)	22.58(28.37)
27	ZG 3	11.65(19.96)	7.50(15.89)	9.58(18.03)
28	ICMB 17333	6.25(14.48)	6.50(14.77)	6.38(14.62)
29	ICMB 101838	17.50(24.73)	15.00(22.79)	16.25(23.77)
30	ICMB 101793	16.33(23.83)	14.50(22.38)	15.42(23.12)
31	ICMB 101840	8.75(17.21)	8.75(17.21)	8.75(17.21)
32	ICMR 101031	2.50(9.1)	5.00(12.92)	3.75(11.17)
33	ICMR 100166	17.92(25.04)	17.25(24.54)	17.58(24.79)
34	J-2571	19.17(25.96)	18.75(25.66)	18.96(25.81)
35	J-2595	12.92(21.06)	11.00(19.37)	11.96(20.23)
36	J-2609	15.00(22.79)	10.50(18.91)	12.75(20.92)
37	J-2612	12.50(20.7)	16.25(23.77)	14.38(22.28)
38	J-2616	0.00(0.00)	0.00(0.00)	0.00(0.00)
39	J-2619	17.50(24.73)	16.00(23.58)	16.75(24.16)
40	J-2634	16.50(23.97)	16.25(23.77)	16.38(23.87)
41	JMSB 20156	12.50(20.7)	15.00(22.79)	13.75(21.77)
42	JMSB 20172	35.00(36.27)	37.50(37.76)	36.25(37.02)
43	203-BCS-21	13.00(21.13)	9.50(17.95)	11.25(19.60)
44	HB-21-1	10.42(18.83)	13.50(21.56)	11.96(20.23)
45	HB-21-2	21.50(27.62)	20.00(26.57)	20.75(27.10)
46	HB-21-3	13.33(21.41)	16.00(23.58)	14.67(22.52)
47	HB-21-4	17.50(24.73)	10.00(18.43)	13.75(21.77)
48	HB-21-5	15.00(22.79)	11.00(19.37)	13.00(21.13)
49	ICMB 01333	50.00(45.00)	20.00(26.57)	35.00(36.27)
50	IP 7846	7.50(15.89)	9.00(17.46)	8.25(16.69)
51	IP 8863-1-1	47.50(43.57)	41.00(39.82)	44.25(41.70)
52	IP 17396-4-1-1	60.50(51.06)	60.00(50.77)	60.25(50.91)
53	IP 20715-1-1-5	12.50(20.7)	9.00(17.46)	10.75(19.14)
54	IP 12374-1-1-2	45.00(42.13)	38.50(38.35)	41.75(40.25)
55	ICMR 08222	13.00(21.13)	17.50(24.73)	15.25(22.99)
56	ICMR 08111	15.00(22.79)	17.50(24.73)	16.25(23.77)
57	ICMR 10888	26.75(31.14)	5.00(12.92)	15.88(23.48)
58	ICMR 06666	18.75(25.66)	10.00(18.43)	14.38(22.28)
59	ICMR 12777	37.50(37.76)	27.50(31.63)	32.50(34.76)
60	ICMR 08444	31.75(34.30)	26.25(30.82)	29.00(32.58)
61	ICMR 11666	12.50(20.70)	0.00(0.00)	6.25(14.48)
62	ICMR 08333	19.00(25.84)	10.00(18.43)	14.50(22.38)
63	ICMR 10999	11.00(19.37)	13.75(21.77)	12.38(20.60)
64	ICMR 11222	27.50(31.63)	22.50(28.32)	25.00(30.00)
65	ICMR 11555	2.75(9.55)	5.00(12.92)	3.88(11.35)
66	ICMR 12666	29.17(32.69)	21.00(27.27)	25.08(30.05)

67	HP-B-458	10.00(18.43)	1.00(5.74)	5.50(13.56)
68	HP-B-460	10.00(18.43)	12.50(20.7)	11.25(19.60)
69	HP-B-465	9.00(17.46)	5.00(12.92)	7.00(15.34)
70	HP-B-467	2.50(9.10)	6.50(14.77)	4.50(12.25)
71	HP-B-488	20.00(26.57)	14.50(22.38)	17.25(24.54)
72	HP-B-489	16.42(23.90)	15.00(22.79)	15.71(23.35)
73	HP-B-502	5.00(12.92)	0.00(0.00)	2.50(9.10)
74	ICMR 11019	27.50(31.63)	20.25(26.74)	23.88(29.25)
75	ICMR 11003	12.92(21.06)	5.00(12.92)	8.96(17.42)
76	ICMR 11009	21.25(27.45)	26.00(30.66)	23.63(29.08)
77	IP 21187-P1	16.25(23.77)	13.50(21.56)	14.88(22.69)
78	ICMR 06444	32.50(34.76)	5.00(12.92)	18.75(25.66)
79	ICMB 97222	3.50(10.78)	5.00(12.92)	4.25(11.90)
80	MDMRRC S1-1-136-1-2-1-B	24.00(29.33)	20.00(26.57)	22.00(27.97)
81	100-SB-21	12.00(20.27)	10.00(18.43)	11.00(19.37)
82	101-SB-21	8.75(17.21)	5.00(12.92)	6.88(15.20)
83	JMSB 20158	6.50(14.77)	7.50(15.89)	7.00(15.34)
84	JMSB 20171	13.50(21.56)	6.50(14.77)	10.00(18.43)
85	JMSB 20191	4.75(12.59)	2.50(9.10)	3.63(10.98)
86	HR-21-6	13.50(21.56)	10.00(18.43)	11.75(20.05)
87	HR-21-7	22.08(28.03)	18.50(25.47)	20.29(26.77)
88	HR-21-8	19.67(26.32)	12.50(20.70)	16.08(23.64)
89	HR-21-9	6.50(14.77)	10.00(18.43)	8.25(16.69)
90	HR-21-10	14.25(22.18)	10.00(18.43)	12.13(20.38)
91	DHLB 30 B	2.75(9.55)	10.00(18.43)	6.38(14.62)
92	DHLB 36 B	0.00(0.00)	1.50(7.03)	0.75(4.97)
93	DHLBI 1825	10.00(18.43)	13.50(21.56)	11.75(20.05)
94	DHLBI 1806	27.50(31.63)	26.50(30.98)	27.00(31.31)
95	DHLBI 1822	18.50(25.47)	13.50(21.56)	16.00(23.58)
96	RVBH 1838	34.40(35.91)	27.50(31.63)	30.96(33.81)
97	RVBH 1839	16.20(23.73)	15.70(23.34)	15.97(23.55)
98	RVBH 1840	19.45(26.17)	13.30(21.39)	16.36(23.85)
99	RVBH 1844	25.00(30.00)	21.50(27.62)	23.25(28.83)
100	JBV-2	21.75(27.80)	9.95(18.39)	15.85(23.46)
	S.Em ±	3.31	3.837	3.33
	CD at 5%	9.30	10.78	9.37

The data given in parenthesis are angular transformed*

Conclusion

A total of 100 genotypes were screened under artificial inoculation showed a wide variation (0.0-60.25%) in the smut severity. Only one entry "J-2616" was found absolutely free from smut. Out of the remaining ninety nine entries, 28, 59,11,1were found in the category of 0.1-10%, 10.1-25%, 25.1-50% and more than 50% respectively. It may be useful for breeders under resistance breeding programme.

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