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Smut Reactions of Pearl Millet Lines and Hybrids with and without Cytoplasmic Male Sterility

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Five male sterile, five maintainer lines and 70 F_1 experimental hybrids possessing sterile and normal cytoplasm of the A1 sterile system were evaluated for their susceptibility to smut by employing an effective field screening technique. Hybrids carrying sterile cytoplasm were not found to be susceptible as against those with normal cytoplasm. It, therefore, appears that in pearl millet the A1 male sterile cytoplasm is not involved in determining the susceptibility to smut. However, significant differences in male sterile and maintainer lines to smut susceptibility may largely be accounted for the rapid pollination in the latter.

Key Words: Pearl millet, *Tolyposporium penicillariae*, **Sterile cytoplasm, Fertile cytoplasm**

Introduction

Pearl millet (*Pennisetum americanum* (L.) Leeke) is a staple food for millions of people in the drier regions of many African countries and India. Cytoplasmic male sterility observed in USA by Burton (1958) and Burton and Athwal (1967) in India helped in the commercial production of hybrids in this crop. As a consequence 75–100% increase in yield over local varieties was observed and reported by Burton and Powell (1968). Large scale cultivation of the homogeneous cultivar of pearl millet in India resulted in the development of epidemic of downy mildew in early seventies and also increased incidence of smut caused by *Tolyposporium penicillariae* Bref. specially on new male sterile lines such as 81A, 842A, 843A; the latter till recently was not considered a disease of economic importance (Ramakrishnan 1963).

Although the disease can be controlled by chemicals, however, this method of control for a crop like millet does not produce a favourable ratios of costs to returns. Consequently, developing the resistant cultivars offers the most practical method of control. It is only recently that the work to determine sources of resistance to pearl millet smut has been undertaken (Hussain & Thakur 1963, Yadav 1974, Pathak & Sharma 1976, Murty 1980, Sangwan & Thakur 1981, Thakur et al. 1983). Based on these reports certain lines have been identified which offer certain degree of resistance. Information, however, on the role of cytoplasm in providing resistance/susceptibility to pearl millet smut is lacking. The present work aims at finding out how pearl millet lines and hybrids with and without cytoplasmic male sterility behave when inoculated with smut?

Materials and Methods

The experimental material consisted of five male sterile lines, five maintainer lines, seven restorer lines and seventy F_1 experimental hybrids based on male sterile (sterile cytoplasm) and maintainer (fertile cytoplasm) lines. The restorer lines used, were selected on the basis of smut susceptibility. Parents and hybrids were grown in separate layouts in two plantings, i.e. E I (July 7, 1985) and E II (July 25, 1985). In each planting, the material was accommodated in a randomized block design with three replicates. For each entry the plot size was $4M^2$. Row to row and plant to plant distances were 60 and 15 centimeters respectively.

Smutted pearl millet inflorescences collected from the 1984 rainy season millet fields at the research farm of

Table 1 *Effect of inoculation and selfing on smut development in pearl millet pollen doners*

Treatment	Smutted florets (%)[a]						
	Environment	ICMPS-101-1	ICMPS-904-3	ICMPS-1600-4	H90/4-5	H833-2	H77-181-4	H77/245
Uninoculated—open	EI	0.00	0.00	0.00	3.33	3.33	33.33	35.00
	EII	0.00	0.00	0.00	5.00	5.00	36.67	40.00
Inoculated—selfing	EI	0.00	0.00	0.00	8.33	5.67	43.33	45.00
	EII	0.00	0.00	0.00	25.00	8.33	50.00	50.00

[a]Mean of 15 inflorescences

Table 2 *Effect of inoculation and selfing on smut development in pearl millet male sterile and maintainer lines*

Treatment	Smutted florets (%)[a]									
	Env.	L111A	L111B	81A	81B	841A	841B	5141A	5141B	10A	10B
Uninoculated—open	EI	58.33	35.00	75.00	70.00	43.33	33.33	38.33	23.33	3.33	1.67
	EII	60.00	58.33	76.67	73.33	63.33	43.33	61.67	31.67	5.00	3.33
Inoculated—selfing	EI	68.33	45.00	83.33	85.00	55.00	48.33	45.00	36.67	8.33	5.00
	EII	73.33	66.67	90.00	85.00	78.33	55.00	80.00	38.33	11.67	8.33
LSD (>0.05)		10.79	26.16	19.18	16.47	5.39	8.42	3.89	4.70	3.89	2.62

[a]Mean of 15 inflorescences

the Haryana Agricultural University, Hissar were used as initial inoculum source. An aqueous spordial suspension (10^6 spordia per milliliter) prepared from initial inoculum was used to inoculate the test plants at the 'boot' stage. The optimum and minimum temperatures and relative humidities were 21 to 37°C and 89 to 42% respectively and precipitation about 216 mm during the course of the experiment for ensuring high degree of infection. The inoculated boots were covered with parchment paper bags and furrows were irrigated at weekly intervals.

In each genotype five inoculated self and uninoculated open inflorescences were scored for per cent smut infection 20–25 days after inoculation using the key similar to the one used for estimating ergot severity (Williams et al. 1977). Data were subjected to angular transformations and analysis of variance. The LSD ($P>0.05$) between treatment means was determined.

Results and Discussion

Table 1 shows that when 7 restorer lines were screened against smut, the three 'ICMPS' lines were highly resistant. Two out of four 'H' lines were moderately resistant and the remaining 2 highly susceptible. Further, the time of inoculation did not materially influence the degree of infection.

Effect of inoculation, selfing and planting dates on smut development in A and B lines is given in table 2. Covering the inoculated 'boot' with parchment bags produced significantly more smut than uninoculated open boot. Significantly more disease was recorded in EII compared to EI. Consistently, all the A lines revealed a greater expression for smut severity than their corresponding B lines. The reduced smut severity in B lines was presumably due to rapid pollination. These observations are in accord to the results of Bhatt (1946) and Thakur et al. (1983). The mean, range, genotypic and phenotypic coefficient of variation (GCV, PCV) values given in table 3 further confirm the above conclusions.

The data obtained on hybrids provided no specific evidence to show that disease levels on hybrids based on male sterile and normal cytoplasm lines are significantly different (table 4). Therefore, it is concluded that response of nucleo-cytoplasmic combinations are not plasmon specific and occurred more or less at random specially in the hybrids. Support to this conclusion is

Table 3 *Effect of inoculation and selfing on smut development in pearl millet sterile and fertile cytoplasm*

Treatment	Env.	Smutted florets (%)[a]							
		Sterile cytoplasm				Fertile cytoplasm			
		Mean ± SE	Range	GCV	PCV	Mean ± SE	Range	GCV	PCV
Uninoculated — open	EI	43.67 ± 7.13	3.33 – 75.00	61.01	61.41	32.67 ± 2.98	1.67 – 70.00	75.44	76.27
	EII	53.33 ± 5.05	5.00 – 76.67	52.04	52.37	42.00 ± 3.07	3.33 – 43.33	63.36	64.00
Inoculated — selfing	EI	52.00 ± 2.48	8.33 – 83.33	53.64	56.20	44.00 ± 5.87	5.00 – 85.00	64.34	66.39
	EII	66.67 ± 2.54	11.67 – 90.00	46.69	47.60	50.33 ± 4.18	8.33 – 85.00	57.16	58.06
LSD ($P>0.05$)		3.23				2.57			

[a]Mean of 45 inflorescences

Table 4 *Smut reactions in pearl millet hybrids based on male sterile and normal cytoplasm employing an effective field screening technique*

Genotype	Smut reaction		Smutted florets[a]									
			L111A S	L111B S	81A S	81B S	841A S	841B S	5141A S	5141B S	10A R	10B R
ICMPS 101 – 1	R	O	0.00	36.67	6.67	15.00	41.67	41.67	13.33	15.00	0.00	0.00
		E	36.66	33.33	45.00	42.50	39.16	27.50	40.00	19.16	5.83	4.16
ICMPS 904 – 3	R	O	16.67	38.00	43.33	41.67	13.33	10.00	36.67	20.00	0.00	0.00
		E	36.67	33.33	45.00	42.50	39.16	27.50	40.00	19.16	5.83	4.16
ICMPS S1600 – 4	R	O	11.67	0.00	10.00	6.67	25.00	5.00	1.67	11.67	1.67	1.67
		E	36.67	33.33	45.00	42.50	39.16	27.50	40.00	19.16	5.83	4.16
H 90/4 – 5	MR	O	28.33	13.33	28.33	25.00	25.00	41.67	43.33	36.67	8.33	5.00
		E	49.16	45.83	57.50	55.00	51.66	40.00	52.50	31.66	18.33	16.66
H833 – 2	MR	O	6.67	5.00	30.00	5.00	25.00	18.33	25.00	30.00	0.00	6.67
		E	40.83	37.50	49.16	46.66	43.33	31.66	44.16	23.33	10.00	8.33
H77/181 – 4	S	O	43.33	36.67	65.00	70.00	16.67	21.67	38.33	65.00	3,33	15.00
		E	61.66	58.33	70.00	67.50	64.16	52.50	65.00	44.16	30.83	29.16
H77/245 – 7	S	O	11.67	20.00	30.00	10.00	18.33	40.00	40.00	60.67	6.67	13.33
		E	61.66	58.33	70.00	67.50	64.16	52.50	65.00	44.16	30.83	29.16

[a]Mean of 15 inflorescences; O, Observed value; E, Expected value; R, Resistant; S, Susceptible

also provided by the fact smut resistance as exhibited by observed and expected smut severity in the hybrids is almost the same.

It is also concluded that resistant seed parents played significant role in obtaining smut resistant hybrids. For example resistant seed parent S10A produced resistant hybrids with resistant or susceptible pollen donors. Resistant hybrids were also obtained from susceptible seed parents and resistant restorers but their frequency was very low.

It is clear that the expression of smut severity in hybrids is under the control of genes, cytoplasms and their interaction and that certain nuclear-genotypic combinations perform better than others.

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