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A New Report of *Bipolaris panici-miliacei* on Pearl Millet

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Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the staple cereal crop best suited to the harsh climate of the seasonably hot, drought-prone, semi-arid regions of Africa and the Indian subcontinent. The relative importance of pearl millet diseases excluding nematodes is downy mildew 45%, *Striga* spp 32%, smut 9%, ergot 7%, rust 3%, viruses >1%, and other diseases 3% (King 1992).

An infected stalk of pearl millet was collected during Oct 1990 from Rajasthan, India. Later a fungus was isolated from the infected portion on potato dextrose agar and submitted for identification to the International Mycological Institute (IMI), London, UK. The fungus was identified as *Bipolaris panici-miliacei* (Nisikado) Shoem (IMI number 344665). The isolate of the fungus has been placed in the IMI herbarium. In literature, the fungus has not been reported on *Pennisetum* spp. However, there are reports from India of its occurrence on *Panicum psilopodium* (Misra et al. 1980), and from Papua New Guinea on *Setaria palmifolix* (Shaw 1921). Therefore, this is presumed to be the first report from India.

Fungal description. Conidiophores are single, or in small groups, dark olivaceous brown, simple, cylindrical, geniculate, 75–255 × 7–11 µm thick, and septate. Conidiogenous nodes and the surface below them are verruculose. Conidia fusoid, dark olivaceous brown, tapering gradually towards the ends, straight to sometimes slightly curved, 2–10 distoseptate, 30–155 × 10–27 µm with dark hilum included within the contour of the basal cell (Sivanesan 1987).

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Dry Stalk Rot – A New Disease of Pearl Millet in Rajasthan

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Introduction

Pearl millet is an important cereal of the semi-arid tropical regions of the world. In Rajasthan, India, pearl millet is cultivated on 4–6 million ha annually, mostly in the western part of the state where annual rainfall is 200–400 mm. No other cereal crops can be grown successfully under these conditions. In this region, both grain and stover yields are important products of pearl millet because animals are a major component of the farming system.

Recently, a new disease – dry stalk rot – has been detected in a number of cultivars and breeding lines at the Agricultural Research Station, Durgapura, Rajasthan and on some cultivars in farmers' fields (Govind Singh, unpublished). A preliminary study of disease etiology, epidemiology, and resistance screening is reported here.

Disease symptoms

The disease appears as blackening, or browning of the stem usually starting above the first node, later exceeding beyond the second, or third nodes from the ground. The flag leaf droops, showing lack of turgidity. The panicle bends slightly and panicle exsertion is retarded, finally resulting in poor grain formation. Tillering appears to be reduced and plants often die before flowering. Such plants develop pin-head black fruiting bodies on the affected internodes (Fig. 1). These are pycnidia of the causal fungus. When the stem is split open, numerous sclerotia are seen and the pith disintegrates leaving vascular bundles free and suspended. This results in drying and withering, and at times causes lodging of infected plants.

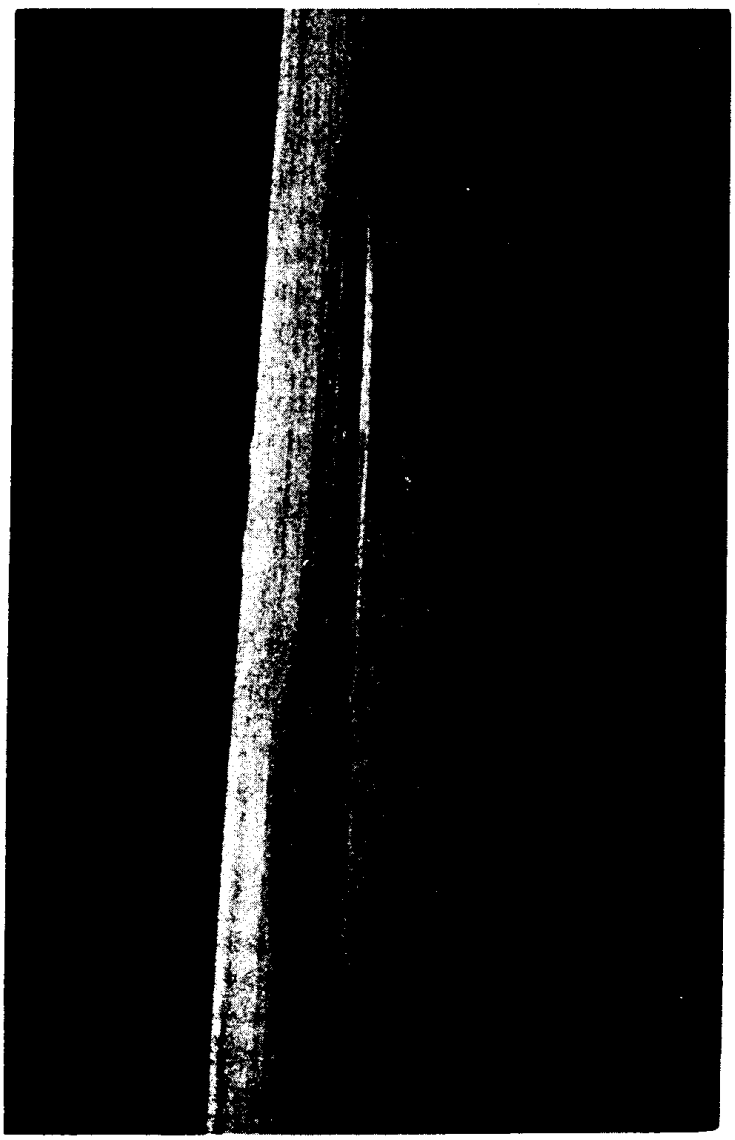

Figure 1. Pycnidia of *Macrophomina phaseolina* causing dry stalk rot of pearl millet.

Causal organism

The pathogen was identified as *Macrophomina phaseolina* (Tassi) Goid (teliomorph of *Rhizoctonia bataticola* (Taub.) Butl.) (Fig. 2). The fungus is highly polyphagous and survives on infected roots, stems, and stubbles in soil (Garrett 1956, Smith 1969, Bhattacharya and Samaddar 1976).

Edaphic and environmental factors

The disease was first noticed at Durgapura Research Station on a local landrace cultivar of pearl millet in 1995. Analyses of soil samples from the field indicated a pH range of 8.5–9.5 with low organic carbon content

Figure 2. *Rhizoctonia bataticola*, the teliomorph of *Macrophomina phaseolina* on dry stalk rot of pearl millet.

Table 1. Meteorological data during the boot-leaf to dough stage of pearl millet development at Durgapura, Rajasthan, India, 1995 and 1996.

	Temperature (°C) (max)		Rainfall (mm)		Relative humidity (%)			
					1995		1996	
Month-week	1995	1996	1995	1996	Min	Max	Min	Max
Sep 1	34.7	32.7	17.0	206.0	78	96	86	93
Sep 2	35.6	35.1	0.0	37.8	75	88	84	94
Sep 3	37.3	34.6	0.0	6.6	52	88	82	89
Sep 4	37.1	36.5	0.0	0.0	52	79	52	73
Oct 1	37.6	36.2	0.0	42.2	47	68	61	95
Oct 2	36.9	34.9	0.0	0.0	47	61	52	84

(–0.5%). Soils on the station are sandy with poor water retention capacity. Average annual rainfall ranges between 350 and 450 mm, and usually ceases by the last week of August. At flowering of pearl millet crop during Aug–Sep, the maximum temperature ranged from 32.7 to 37.3°C and relative humidity (RH) from 52 to 84% in 1995 and 1996, resulting in severe drought stress that induced dry stalk rot disease (Table 1). Similar observations have been reported for charcoal rot of sorghum caused by *M. phaseolina* (Edmunds 1964, Edmunds and Voigt 1966, Odvody and Dunkle 1979).

Field screening for disease resistance

The pathogen was isolated from infected pearl millet stems and grown on potato-dextrose agar plates at 28°C. Plants were inoculated by inserting toothpicks infected with mycelia and sclerotia of the fungus (Hsi 1966) into the second node at the boot-leaf stage. Thirty-two entries of pearl millet (released and pre-released hybrids and open-pollinated varieties) and six entries of sorghum (breeding lines) were grown, in single 4-m rows, on the research farm at Durgapura during 1996, and screened for resistance to dry stalk rot. Ten plants of each entry were inoculated and plants were scored at the late dough stage using a modified rating scale (Hsi 1961), where; 0 = no lesion, 1 = lesion up to 10 cm in the pith, 2 = lesion 10.1–20 cm, 3 = lesion 20.1–30 cm, and 4 = lesion >30 cm. On the modified rating scale, the number of nodes was substituted by the length of lesion development in the pith and the formation of sclerotia and pycnidia. The development of pycnidia and sclerotia were scored as low, medium, or high. Pycnidial formation in an entry was considered as a highly susceptible trait, as it provided an easy source of secondary inoculum.

Disease reaction in pearl millet

Of the 32 entries screened, none was free from stalk rot (Table 2). The shortest lesions were recorded in RCB-IC 9 (Raj 171), RCB-IC 325, and HHB 67. The least sclerotial development was found in ICMV 96842, ICMV 96844, ICMV 96833, RCB-IC 948, ICMV 95845, CZP-IC 416, CZP-IC 315, and ICTP 8203; and some of these showed complete disintegration of the pith. Lesion color in the pith varied from reddish brown to gray, and gray pith supported more sclerotial and pycnidial development. Of the eight entries with very low sclerotial development, six did not develop any pycnidia, and two had very low pycnidial development. Pycnidia did not develop on nine other entries that supported medium to high sclerotial development.

Disease reaction in sorghum

Of the six sorghum lines screened, four recorded high development of sclerotia in the pith, while pycnidia developed only on one line (Table 2). Pith color varied from reddish brown to gray.

Conclusions

Further research is required to determine the repeatability of the screening results across seasons and growing conditions. Many of the tested entries were open-pollinated varieties derived from broad-based populations of varying genetic background. These entries are expected to be genetically heterogeneous, and thus it would be useful to assess the range of disease reactions. This would help in improving the level of resistance in already released and

Table 2. Disease reactions of pearl millet and sorghum entries to inoculation with *Macrophomina phaseolina* at Durgapura, Rajasthan, India, 1996.

Entry	Disease rating (0–4)	Lesion length (cm)	Lesion color[1]	Sclerotia[2]	Pycnidia[2]
Pearl millet					
ICMV 96840	1.2	12.1	Red Br	++	++
ICMV 96841	1.2	12.1	Red Br	++	–
ICMV 96842	1.1	11.1	Red Br	+	–
ICMV 96843	1.1	11.3	Gr	+++	+
ICMV 96844	1.6	16.5	Brown	+	–
ICMV 96845	1.2	11.8	Br Gr	++	++
ICMV 96846	1.2	11.8	Br Gr	++	++
ICMV 96847	2.2	22.5	Gr	+++	+++
ICMV 96830	0.9	9.0	Br	++	++
ICMV 96831	2.5	24.6	Gr	+++	+++
ICMV 96832	1.3	12.7	Gr	+++	+++
ICMV 96833	1.1	10.9	Gr Bl	+	+
ICMV 221	1.1	11.1	Red Br	++	+
RCB-IC 948	1.1	11.3	Red Br	+	–
ICMV 95845	1.7	16.7	Br	+	–
CZP-IC 416	1.8	18.2	Br	+	+
CZH-IC 314	1.1	11.3	Red Br	++	–
ICMP 94851	1.3	12.9	Gr	+++	++
CZP-IC 315	1.3	13.1	Br	+	–
MCB-IC 531	1.3	12.6	Gr	+++	++
Nokha Local	1.4	14.5	Br	++	+
HHB 67	0.7	7.5	Red Br	++	–
RCB-IC 9 = Raj 171	0.6	6.0	Red Br	++	–
ICMV 155	1.2	12.5	Br	++	–
ICTP 8203	1.9	19.2	Br	+	–
CZP 9401	1.9	19.5	Br	++	–
CZ-IC 923	1.4	14.2	Br	++	–
RCB-IC 856	1.8	17.6	Gr Br	++	++
RCB-IC 325	0.7	7.5	Br	+++	–
RCB-IC 525	1.1	11.5	Br	++	++
Pusa 23	2.4	24.0	Gr	+++	–
ICMH 451	3.7	37.0	Gr	+++	++
Sorghum					
RL 16	1.5	15.2	Gr	+++	++
R 16	1.4	14.5	Br	+++	–
RTx 7078	1.5	14.7	Red Br	+++	–
GD 45454	1.1	11.5	Red Br	++	–
SPV 86	1.9	19.0	Gr	+++	–
Durgapura Local	1.7	17.5	Red Br	+++	–

1. Gr = gray, Red Br = reddish brown, Br = brown, and Bl = black.
2. + = low, ++ = medium, +++ = high development of sclerotia and pycnidia, and – = no pycnidial development.

pre-released open-pollinated varieties as CZ-IC 923, RCB-IC 856, and ICMV 95845.

The *M. phaseolina* isolate from pearl millet infected sorghum, and therefore poses a new threat for fast development of inoculum in the soil. Studies on charcoal/stalk rot of sorghum (Mughogho and Pande 1984) have indicated that the higher soil pH and low organic carbon prevailing during terminal drought stress after anthesis in cultivars with long and juicy stems, and high biomass render them susceptible to dry stalk rot. It would therefore be useful to identify dwarf and early-maturing cultivars of pearl millet for dry areas that are prone to stalk rot. The role of cultivating legumes in perpetuating the inoculum needs to be investigated.

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Downy Mildew Reactions of Pearl Millet Varieties and Parents

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Introduction

Downy mildew (DM), caused by *Sclerospora graminicola* (Sacc.) J. Schröt., became a major crop production constraint in hybrid pearl millet (*Pennisetum glaucum* (L.) R. Br.) in India in the early 1970s, and is still a potential threat to pearl millet production in both India and several African countries. The discovery of cytoplasmic genetic male-sterility in pearl millet (Burton 1958) encouraged the production of F_1 hybrids. Many accessions with high levels of resistance have been evaluated and their progenies are highly resistant and agronomically acceptable (Singh et al. 1987). Selected pearl millet varieties/hybrids, and their parents, including male-sterile (ms) lines, maintainers, and restorers, have been tested for DM resistance at Hisar. The results of these studies are reported.

Materials and methods

Entries were tested from 1991/92 to 1995/96 (five consecutive seasons) in a DM sick-plot where soil was inoculated with DM oospores every year before the millet was sown. The field-screening technique suggested by Williams et al. (1981) was followed with minor modifications. Infector rows of NHB 3 + 7042 DMS were sown every 3rd row, 3 weeks prior to sowing the test rows. The plot size was a single 5-m row, 0.75 m apart from other rows, and plants within the row were spaced at 10–15 cm. The experiment was sown in a randomized complete block design with three replications. DM was recorded as the percentage of the plants infected at 30 and 60 days after sowing. The mean DM incidence of two records is given in Table 1.

Results and discussion

Out of 23 entries tested, 2 hybrids (HHB 50 and HHB 68) and 2 ms lines (841A and ICMA 88004) remained free from DM in all seasons. Five entries (J 2002, Pusa 23, HHB 60, HHB 67, 81B, and H 90/4-5) were highly resistant to DM (<1% mean DM incidence). A maximum of 32.1% mean DM incidence was recorded in ICMP 451,