Pathology

A Highly Virulent Pathotype of *Sclerospora graminicola* from Jodhpur, Rajasthan, India

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Introduction

Downy mildew of pearl millet (*Pennisetum glaucum* (L.) R. Br.), caused by *Sclerospora graminicola* (Sacc.) J. Schröt., continues to be a serious problem in India. With the commercial cultivation of genetically uniform F_1 hybrids, emergence of several cultivar-specific virulences have been detected (Thakur and Rao 1997), and popular hybrids such as HB 3, BJ 104, MBH 110, and MLBH 104 have had their resistances overcome by downy mildew. So far four cultivar-specific pathotypes have been identified based on their high susceptibility in farmers' fields (Thakur et al. in press). During the 1997 rainy season, the pearl millet crop at the farms of the Central Arid Zone Research Institute (CAZRI) and the Agricultural Research Station, Mandor, both at Jodhpur, Rajasthan, recorded severe downy mildew incidence on released hybrid ICMH 451, many elite breeding lines, and several local landrace populations. A number of breeding lines from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the All India Coordinated Pearl Millet Improvement Project (AICPMIP) that were resistant to the known pathotypes of *S. graminicola* showed extreme susceptibility at both locations. Several of the well-established male-sterile lines (863A, 81A, 843A, and 852A) that are being used extensively in hybrid breeding also recorded high downy mildew incidence (Table 1). The extreme susceptibility of some of the highly resistant lines was probably due to emergence of a new virulence in the pathogen population. Our objective in this investigation, therefore, was to determine the pathological identity of the population of *S. graminicola* from Jodhpur.

Table 1. Downy mildew incidence (%) on selected homogenous pearl millet genotypes at agricultural research stations of the Central Arid Zone Research Institute (CAZRI, Jodhpur) and the All-India Coordinated Pearl Millet Improvement Project Coordinating Unit (AICPMIP, Mandor) during the 1997 rainy season.

	CAZRI		
Host genotype	Field 1	Field 2	Mandor
863A	100	10	100
81A	100	58	88
841A	0	19	42
843A	25	30	74
852A	88	54	92
MBH 110	14	27	40
7042S	100	88	96

Source: Data provided by A S Rao, Genetic Resources and Enhancement Program, ICRISAT.

Materials and methods

We collected oosporic inoculum from infected plants of a local landrace cultivar, Nokha Local, that had been used as a control entry in several collaborative trials conducted at the Jodhpur research farm of CAZRI. This entry recorded 50–80% downy mildew incidence in the field. We assumed, perhaps incorrectly, that this local cultivar would not carry much in the way of resistance genes and hence would not have screened out specific virulences from the pathogen population. We produced asexual spores on the seedlings of Nokha Local (seeds courtesy of Eva Weltzein Rattunde) grown in oospore-infested pot soil in a greenhouse at ICRISAT-Patancheru. This isolate (as a bulk population) was designated as Sg 139 and will be referred as such throughout this article. The isolate was then transferred as asexual spores to 7042S, a highly susceptible inbred line that supports better sporulation than Nokha Local. This asexual inoculum collected from 7042S was used for all subsequent greenhouse inoculation experiments. No change in virulence was expected with this change, because 7042S is universally susceptible to all previously tested pathogen populations. Data from Table 2 showed that the asexual spores of Sg 139 from Nokha Local produced 92% incidence on IP 18292 and 94% incidence on 7042S.

We conducted three greenhouse experiments involving Sg 139 and other known pathotype isolates, and also summarized relevant data from breeding material screening where this isolate was used. Path-1 through Path-5 are host-specific pathotypes multiplied on their

Table 2. Downy mildew incidence (%) on a set of pearl millet differential lines inoculated with known pathotypes and Sg 139 (Nokha Local) in a greenhouse experiment at ICRISAT-Patancheru.[1,2]

Pathotype (isolate)[3]	Pearl millet line				
	IP 5272-1	IP 18292	IP 18296	IP 18297	7042S
Path-1 (Sg 008)	0	0	0	3	84
Path-2 (Sg 009)	0	0	0	1	83
Path-3 (Sg 010)	0	0	0	2	90
Path-4 (Sg 011)	0	0	48	2	93
Path-5 (Sg 012)	0	0	37	0	96
Path-6 (Sg 021)	0	1	0	5	67
Nokha Local (Sg 139)	74	92	10	6	94
SE isolate × line = ± 4.9					

1. Mean of three replications with at least 100 seedlings replication^{-1}.
2. Experiment conducted by Kirti Pathak, Apprentice (MSc Botany candidate, University of Pune, Maharashtra, India).
3. Cultivar-specific pathotypes Path-1 (NHB 3); Path-2 (BJ 104); Path-3 (MBH 110); Path-4 (852B); Path-5 (700651); and Path-6 (MLBH 104).

respective hosts. Path-6 was only multiplied on 7042S. Sg 139 was multiplied on Nokha Local for the experiment shown in Table 2, while for the rest of the experiments it was multiplied on 7042S.

Results and discussion

In the first experiment, isolates of six standard pathotypes (Thakur and Rao 1997), along with Sg 139, were inoculated on five pearl millet differential lines. Isolate Sg 139 induced very high disease incidence on IP 5272-1 (74%) and IP 18292 (92%), while these lines remained downy mildew-free following inoculation with all six other isolates (Table 2). In other experiments where isolates Sg 139 and Sg 008 (Path-1) were used, IP 18292 recorded over 80% incidence when inoculated with Sg 139, while it remained nearly disease-free (3% incidence) when inoculated with Sg 008 (Tables 3 and 4).

Table 3. Downy mildew incidence (%) on three pearl millet lines inoculated with two pathotypes of *Sclerospora graminicola* under greenhouse conditions at ICRISAT-Patancheru.

Pathotype (isolate)	Host genotype		
	IP 18292	IP 18293	7042S
Nokha Local (Sg 139)	87	35	97
Path-1 (Sg 008)	3	0	86

IP 18292 has previously been resistant to all downy mildew pathotypes against which it has been screened. Further, this resistance has been demonstrated to have a strong monogenic dominant component (Singh and Talukdar 1998). This line has been used as a resistance donor by several public and private sector breeders in India. With the identification of a virulence matching the resistance in IP 18292, it is likely that this resistance will not hold for long, even in other parts of India if it is deployed in isolation from other resistance genes. It is important, therefore, that the users of IP 18292 be aware of this information. They should diversify the sources of resistance being used in their breeding programs and should not expect the resistance from IP 18292 to hold up if it is deployed in a genetically uniform background that is otherwise susceptible to downy mildew. Results from molecular mapping of resistance genes from IP 18292 confirm the Mendelian inheritance studies and suggest that it would be dangerous to use this line as a sole source of resistance to downy mildew in India, or elsewhere (Hash et al. unpublished).

The disease symptoms induced by isolate Sg 139 on IP 18292 are leaf chlorosis, stunted plant growth, and very scanty sporangial sporulation, which are typical of those induced on hybrid BJ 104 and its parental line 5141A. Symptoms induced on other host genotypes by this isolate include normal leaf chlorosis, no stunting of seedlings, and profuse asexual sporulation.

Several other resistance donor lines (P 7-4, P 310-17, 700651, 7042R, ICMP 85410, and IP 18293) recorded much higher incidence of downy mildew when inoculated

Table 4. Downy mildew incidence (%) in pearl millet lines induced by the Path-1 isolate and Nokha Local isolate in a greenhouse experiment at ICRISAT-Patancheru.

Line	Downy mildew isolate used	
	Path-1 (Sg 008)	Nokha Local (Sg 139)
P 7-4	7	40
P 310-17	6	17
700651	3	34
7042R = ICML 22	17	63
ICMP 85410	18	60
IP 18292	3	81
IP 18293	0	34
852B	9	70
MBH 110	1	20
J 104	84	56

Table 5. Downy mildew incidence (%) on three homogenous pearl millet genotypes induced by *Sclerospora graminicola* isolate Sg 139 from Nokha Local (pooled data from 20 screens of breeding lines from Rajasthan) under greenhouse conditions at ICRISAT-Patancheru, during Mar–May 1998.

Host genotype	Mean disease incidence and range (%)
7042S	89 (86–100)
NHB 3	9 (0–20)
ICMB 88004	3 (0–12)

with Sg 139 than in the case of Sg 008 (Table 4). This again suggests resistance from a single donor may not provide adequate protection against this pathotype.

From large scale screens of breeding lines (more than 3000 entries in 20 screens) from Rajasthan against Sg 139 under greenhouse conditions at ICRISAT-Patancheru we found that when used as susceptible checks, NHB 3 scored 9% (0–20% range) and 7042S scored 89% (86–100%) incidence (Table 5).

NHB 3, one of our standard susceptible checks, which has the pedigree 5071A × J 104, is moderately resistant to this new pathotype. Data from the above experiments and observations clearly suggest that Sg 139 is different from the previously described pathotypes of *S. graminicola.* It is the most virulent isolate reported to date from India. Based on these results, we tentatively designate the Nokha Local population of *S. graminicola* from Jodhpur as a new virulence pathotype, Path-7, represented by isolate Sg 139. We will further confirm this virulence diversity using molecular marker techniques.

References

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