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Development and characterization of genetic stocks in pearl millet (*Pennisetum glaucum*) resistant to downy mildew (*Sclerospora graminicola*)

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Downy mildew or green ear caused by *Sclerospora graminicola* (Sacc.) Schroet. is the most important disease of pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz]. This causes severe loss in grain yield due to complete or partial conversion of florets into leafy structures (Singh *et al.* 1993). Since host-plant resistance is the most feasible method to control this disease, about 300 genetic stocks developed from the spontaneously occurring mutants in the world collection of pearl millet germplasm were screened for resistance to downy mildew. This paper contains the origin of the mutants and development of genetic stocks, describes their morphological and agronomical characters, and gives their potential use in pearl millet improvement.

During the course of evaluation, with rejuvenation and seed increase of 24 600 germplasm accessions since 1978, about 300 genetic stocks were isolated, purified and made true breeding at the Asia Centre of the institute at Patancheru. All the mutants were evaluated for several morphological and agronomic characters during the rainy and post-rainy seasons (Appa Rao *et al.* 1987). Data were analysed using Genstat software. Screening for downy mildew resistance was done at 3 locations in India (Patancheru, Mysore and Aurangabad) and 3 locations in western Africa (Bengou, Sadore and Cinzana) during 1991 93 in greenhouse or field disease nurseries (Singh and Gopinath 1985, Singh *et al.* 1993).

The dwarf, white-sheath, glossy and yellow mutant, registered as 'IP 18292', was derived from a multiple-cross involving different parents. The dwarfing gene **d_2d_2** is from **Tifton** (Burton and Fortson 1966); the white-sheath trait gene **wsws** is from 'IP 7626' from India.(Appa Rao *et al.* 1990); and the glossy-trait gene **gl_1gl_1** is from 'IP 8275' from India (Appa Rao *et al.* 1987). All these traits are controlled by single recessive genes (Anand Kumar and Andrews 1993).

The bleached-leaf mutant registered as 'IP 18293' was isolated from a segregating population of a cross between 'IP 10399'

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(India) and 'IP 10729' (Sudan). This trait, distinguishable 10 days after emergence, is controlled by a single recessive gene **blbl** (Appa Rao *et al.* 1990).

The zebra mutant, with transverse yellow bands alternating with green ones on leaves and stem, was isolated from an accession 'P 5307' from Mali. This trait is controlled by single recessive gene **zz** and the mutant was registered as 'IP 18294'. The yellow mutant was isolated from an accession 'IP 11629' from Cameroon. It develops yellowish-green foliage with shiny leaf surface, which is distinguishable at all growth stages. It was registered as 'IP 18295'. This trait is controlled by a single recessive gene. An accession 'PI 287041' from Nigeria was segregated for normal and glossy plant types. The progeny of true-breeding glossy plants, named 'Glossy 17', was later registered as 'IP 18296'. An accession 'P 412' from Mali (Clement 1985) also segregated for normal and glossy, and the true-breeding glossy plants ('Glossy 29') was registered as 'IP 18297'. Similarly, the glossy-plant progeny of accession 'CVP 610' from Burkina Faso ('Glossy 38') was registered as 'IP 18298'.

At Patancheru these accessions flowered in 59–116 days, grew 84–240 cm tall, with spike length 15·39 cm and spike thickness 16–30 mm during the rainy season; and in 59–93 days, 83–160 cm tall, with 13·41 cm spike length and 17·29 mm spike thickness in post-rainy season. This shows considerable variation in growth pattern of these mutants between the 2 growing seasons (Table 1).

The incidence of downy mildew in these accessions was 0–90% in the laboratory and field-disease nursery at Patancheru. Among these, 7 mutants ('IP 18292', 'IP 18293', 'IP 18294', 'IP 18295', 'IP 18296', IP 18297 and 'IP 18298') showed stable resistance to the 3 major pathotypes (Mysore, Patancheru and Aurangabad) occurring in India. During the

Table 1 Diversity for agronomic characters of pearl millet genetic stocks resistant to downy mildew*

Character	Season	'IP 18292'	'IP 18293'	'IP 18294'	'IP 18295'	'IP 18296'	'IP 18297'	'IP 18298'
Time to flower (days)	R	59 ± 0·9	78 ± 2·0	82 ± 2·4	72 ± 0·9	69 ± 1·8	76 ± 1·2	116 ± 2·4
	PR	75 ± 7·2	90 ± 3·0	81 ± 4·9	81 ± 5·9	93 ± 2·2	67 ± 1·6	59 ± 4·5
Plant height (cm)	R	99 ± 11·3	84 ± 9·0	240 ± 15·8	124 ± 8·5	175 ± 5·0	216 ± 13·8	234 ± 5·5
	PR	95 ± 12·4	93 ± 4·8	151 ± 4·3	83 ± 3·2	158 ± 2·5	160 ± 0·0	126 ± 2·4
Exsertion (cm)	R	8 ± 0·4	5 ± 0·3	8 ± 0·6	4 ± 0·6	7 ± 0·5	7 ± 0·6	3 ± 0·2
Spike length (cm)	R	36 ± 1·2	21 ± 1·8	30 ± 1·8	15 ± 0·3	39 ± 3·0	28 ± 1·8	19 ± 0·6
	PR	28 ± 2·1	19 ± 0·5	29 ± 1·1	13 ± 1·1	41 ± 3·4	28 ± 1·2	18 ± 1·4
Spike thickness (mm)	R	18 ± 1·2	17 ± 2·0	30 ± 1·7	16 ± 0·7	20 ± 0·5	20 ± 1·4	20 ± 0·0
	PR	18 ± 1·3	17 ± 0·8	29 ± 0·8	17 ± 1·3	24 ± 0·9	20 ± 0·6	21 ± 1·0
Total tillers	R	1·7 ± 0·1	3·6 ± 0·3	1·9 ± 0·2	4·5 ± 0·3	1·7 ± 0·1	1·5 ± 0·1	2·8 ± 0·3
Productive tillers	R	1·5 ± 0·1	2·7 ± 0·2	1·5 ± 0·1	3·5 ± 0·4	1·5 ± 0·1	1·3 ± 0·1	2·5 ± 0·3
1 000-grain weight (g)	PR	6·0 ± 0·8	5·0 ± 0·6	8·0 ± 0·5	5·5 ± 0·6	4·5 ± 0·3	4·5 ± 0·4	9·5 ± 0·6

*Data show mean ± SE

R, Rainy season; PR, post-rainy season

initial tests in Niger and Mali in western Africa, 'IP 18292', 'IP 18293', 'IP 18294', 'IP 18295' and 'IP 18298' remained free from the downy mildew disease in pots and in downy mildew nurseries for 30 days after sowing. The complete resistance possessed by some of these mutants ('IP 18292' and 'IP 18298') was not detected in many lines so far tested (Singh 1990). An important feature of these lines is that each of them possesses a specific phenotypic marker trait that will help in maintaining purity of each line, as the outcrossed plants could be easily identified.

As the resistance to downy mildew is controlled by 1 2 dominant genes with some modifiers (Singh *et al.* 1993), it is easy to transfer resistance to high-yielding elite background for sustainable increase in pearl millet production. There is need to identify any association between the phenotypically marker trait and downy mildew resistance, and the allelic relationships existing in these 7 resistant stocks.

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