

Evaluation of Pearl Millet Male-sterile Lines and their Maintainers for Resistance to Downy Mildew and Smut

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Introduction

Downy mildew caused by *Sclerospora graminicola* (Sacc.) Schroët. and smut caused by *Moesziomyces penicillariae* (Bref.) Vanky are the most important diseases (in that order) limiting the productivity of pearl millet [*Pennisetum glaucum* (L.) R. Br.] in Asia and Africa (Thakur et al. 1992; Singh et al. 1993). These diseases are more serious on commercial F₁ hybrids than on open-pollinated varieties. Development of cytoplasmic male-sterile lines (A-lines) with genetic diversity and disease resistance is a continuous process at ICRISAT-Patancheru, India (Thakur et al. 2001). Resistance to downy mildew and smut in hybrid parents has a direct bearing on breeding hybrids resistant to these diseases. With this objective in view, eight A/B-lines were evaluated for resistance to downy mildew and smut in the disease nursery at ICRISAT-Patancheru during the rainy season of 2005, the results of which are reported here.

Materials and Methods

Greenhouse evaluation for downy mildew resistance.

Two pathotypes of *S. graminicola* — Sg 409 from Patancheru (Andhra Pradesh state of India) and Sg 212 from Durgapura (Rajasthan state of India) — having differential virulence (Rao et al. 2005) were used in the study. Six pairs of male-sterile lines (A-lines) and their maintainers (B-lines) were used as test lines, while two pairs of released A/B lines and 7042S were used as susceptible controls for both diseases (Table 1). Each of the eight pairs of A/B lines and 7042S was sown in pots with five replications with 35–40 seedlings per pot per replication. These were inoculated with the asexual sporangial suspension (1×10^6 sporangia mL⁻¹) of each of the two pathotypes at the first-leaf stage under controlled conditions during March-April 2005.

The total and diseased seedlings were counted 14 days after inoculation to estimate disease incidence.

Table 1. Parentage of pearl millet male-sterile lines and their maintainers evaluated for downy mildew and smut resistance at ICRISAT-Patancheru, Andhra Pradesh, India, rainy season, 2005.

| Identity | Pedigree |
|-----------------|---|
| ICMA 88006 | 81A cytoplasm source (A ₁) backcrossed to ICMB 88006 |
| ICMB 88006 | [(81B × SRL 53-1) × 843B]-30-2-B |
| ICMA 92444 | 81A cytoplasm (A ₁) backcrossed to ICMB 92444 |
| ICMB 92444 | (843B × ICMP5-1500-7-4-1-6)-23-1-B-1-4 |
| ICMA 92777 | 88006A cytoplasm (A ₁) backcrossed to ICMB 92777 |
| ICMB 92777 | [843B × (ICMPS 500-4-4-3 × ICMPS 1800-3-1-2-C3-4)]-7-1-3 |
| ICMA 92888 | 88006A cytoplasm (A ₁) backcrossed to ICMB 92888 |
| ICMB 92888 | (843B × ICMPS 900-9-3-2-2)-41-2-6-2-2 |
| ICMA 93111 | 88006A cytoplasm (A ₁) backcrossed to ICMB 93111 |
| ICMB 93111 | [(81B × SRL 53-1) × 843B]-30-1-1 |
| ICMA 93333 | 88006A cytoplasm (A ₁) backcrossed to ICMB 93333 |
| ICMB 93333 | (843B × ICMPS 900-9-3-8-2)-21-8-4 |
| Controls | |
| 81A | Tift 23D ₂ A cytoplasm source (A ₁) backcrossed to 81B |
| 81B | Induced downy mildew-resistant selection from Tift 23D ₂ B |
| 841A | 5141A cytoplasm source (A ₁) backcrossed to 841B |
| 841B | DM-resistant selection from seed lot number 8015 of 5141B |
| 7042S | Susceptible control |

Table 2. Downy mildew¹ incidence and smut severity of eight A/B lines evaluated under field and greenhouse conditions at ICRISAT-Patancheru, Andhra Pradesh, India, rainy season, 2005.

| Identity | Downy mildew incidence (%) ² | | | Smut severity (%) ³ |
|--------------------|---|--------|------------|--------------------------------|
| | Greenhouse | | Field | |
| | Sg 409 | Sg 212 | Soft-dough | |
| ICMA 88006 | 79 | 50 | 23 | 30 |
| ICMB 88006 | 62 | 45 | 15 | 27 |
| ICMA 92444 | 79 | 88 | 11 | 0 |
| ICMB 92444 | 93 | 90 | 10 | 0 |
| ICMA 92777 | 2 | 0 | 3 | 0 |
| ICMB 92777 | 1 | 0 | 3 | 0 |
| ICMA 92888 | 99 | 97 | 13 | 0 |
| ICMB 92888 | 95 | 98 | 16 | 0 |
| ICMA 93111 | 99 | 29 | 13 | 35 |
| ICMB 93111 | 99 | 39 | 26 | 40 |
| ICMA 93333 | 74 | 41 | 6 | 40 |
| ICMB 93333 | 62 | 47 | 7 | 33 |
| Controls | | | | |
| 81A | 93 | 76 | 30 | 89 |
| 81B | 92 | 96 | 31 | 94 |
| 841A | 88 | 65 | 3 | 84 |
| 841B | 62 | 63 | 4 | 68 |
| 7042S | 99 | 97 | 100 | 97 |
| Mean | 75 | 60 | 18 | 37 |
| SE(m)± | 3.5 | 2.1 | 3.2 | 2.2 |
| LSD ($P < 0.05$) | 10.0 | 5.7 | 9.1 | 6.2 |

1. Downy mildew pathotype Sg 409 from Patancheru and Sg 212 from Durgapura.

2. Mean of five replications based on total and diseased plants both in field and greenhouse.

3. Mean of five replications, 10 plants per replication under artificial inoculation in field.

Field evaluation for downy mildew resistance. All eight A/B pairs and 7042S were planted in the downy mildew nursery at ICRISAT-Patancheru during the rainy season of 2005. Each line was grown in a single-row plot of 4 m with five replications in a randomized complete block design, and thinned 10 days after emergence leaving 40 seedlings in each row. Perfo irrigation was provided from the seedling emergence stage for about 2–3 weeks for disease development.

Disease incidence was recorded by counting the total and infected seedlings at the pretillering and soft-dough stages. Since there was an increase in disease incidence from the pretillering to the soft-dough stage in some lines, the data recorded at the latter stage was considered for analysis and reporting.

Field evaluation for smut resistance. The downy mildew-resistant plants in the nursery were inoculated with a sporidial suspension of smut at the boot-leaf stage following the standard procedure (Thakur et al. 1992). Ten plants were inoculated at boot in each line/replication and covered immediately with parchment paper bags.

High humidity was provided through overhead sprinklers from inoculation onward for 20 days for disease development. The inoculated panicles were scored for smut severity as a percentage of florets with smut sori 25–30 days after inoculation.

Data analysis. The data were subjected to analysis of variance to find significant differences between the A/B lines for both downy mildew incidence and smut severity.

Results and Discussion

Downy mildew resistance. Of the six A/B pairs evaluated in the greenhouse against the Patancheru and Durgapura pathotypes of downy mildew, only one pair, ICMA/B 92777, was resistant with $\leq 2\%$ incidence of both pathotypes. The remaining five A/B pairs showed disease incidence ranging from 62% to 99% to the Patancheru pathotype, and from 29% to 98% to the Durgapura pathotype compared to 97–99% incidence in the susceptible control 7042S (Table 2).

In field evaluation, two pairs, ICMA/B 92777 and ICMA/B 93333, were resistant with $\leq 7\%$ incidence and one pair, ICMA/B 92444, had $\leq 11\%$ incidence at the soft-dough stage. The remaining three A/B pairs had incidence levels ranging from 13% to 26% compared to 100% incidence in 7042S (Table 2). The control pair 841A/B was also resistant in the field with $\leq 4\%$ incidence, while 81A/B had 30-31% incidence. Of the six A/B pairs tested, only one, ICMA/B 92777, showed resistance ($\leq 3\%$ incidence) in both greenhouse and field evaluations.

Smut resistance. Three pairs, ICMA/B 92444, ICMA/B 92777 and ICMA/B 92888, were free from smut, and the remaining pairs had severity levels ranging from 27% to 40% compared to 89-94% in 81A/B and 97% in 7042S (Table 2). These three pairs could be utilized in developing smut-resistant hybrids.

One pair, ICMA/B 92777, which was resistant to both downy mildew and smut, could be used in resistance breeding for developing hybrids with resistance to both diseases.

There were no significant differences between A- and B-lines within a particular A/B pair for both downy mildew

incidence and smut severity, indicating that male-sterility had no effect on susceptibility to these diseases.

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