Grain mold can also be avoided by cultivating the crop in the postrainy season or in areas where this problem is less severe, and by such management practices as ratooning. SPV 839, SPH 606, and M 35-1, which are suited to postrainy season cropping, can be sown immediately after the break of the monsoon, harvested for green fodder at flowering, and then ratoon-harvested as a grain crop. Such practices, which require a total of 150–155 days, give 3.0–3.5 t of grain, 20–25 t of green fodder, and 8–10 t of dry fodder ha^{-1}.

Chemicals

Chemical control with such fungicides as captan + Dithane M 45 (mancozeb) and Bavistin® (carbendazim) + thiram reduces the severity of grain mold infection and increases seed germination by 15–20% over that in the unsprayed control. Recently, a new group of plant multiprotectants, the triazoles, has been introduced. Triazole derivatives are toxic to fungi and also regulate plant growth.

Genetic resistance

The third and the most important strategy is resistance breeding, which involves four important factors associated with genetic resistance:

- High tannin content
- High level of flavin-4-ols
- Grain hardness
- Panicle looseness and glume coverage.

The ability of grains with a pigmented testa to resist mold development is attributed to their high tannin content. However, genotypes containing high tannin levels are not acceptable in India, and this character has a limited value in resistance breeding. Similarly, sorghum grains with red pericarp, which contain high levels of the flavin-4-ols that confer resistance to grain mold, are not acceptable. Grain hardness is associated with smaller seed size and grain mold resistance. It is generally observed that lax, open panicles and seeds covered by glumes help avoid grain mold infection. It is essential to combine 2–3 resistance factors to develop agronomically acceptable genotypes. In certified hybrid seed (A × R) production, either colored or chalky parents can be used at the A × B stage to reduce the grain deterioration. Our experience indicates that grain deterioration is less in chalky-grained male-sterile line CK 60A than in 296 A and 2077 A.

Under our conditions, a combination of grain hardness, lax panicles (while maintaining the grain number), and glume coverage (with easy threshability) promises to be the most suitable combination of characters to impart resistance to grain mold in sorghum. At Parbhani, such grain mold resistant lines as GMRP 4, GMRP 9, GMRP 13, GMRP 25, GMRP 28, and GMRP 33 have been developed using this approach.

Evaluation of Early-flowering Sorghum Germplasm Accessions for Downy Mildew Resistance in the Greenhouse

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Sorghum downy mildew (SDM), caused by *Peronosclerospora sorghi* (Weston & Uppal) C.G. Shaw, is a serious disease of sorghum [*Sorghum bicolor* (L.) Moench] and maize (*Zea mays* L.) in different parts of the world (Williams 1984); it can cause substantial losses in yield (Craig and Odvody 1985). Resistant cultivars being the best method to combat this disease, there is a need for continual search for stable sources of resistance. In an effort to identify new sources of resistance, 2707 sorghum germplasm accessions (from ICRISAT's Genetic Resources Division), which flower in less than 80 days at ICRISAT Asia Center (IAC), Patancheru, India, were screened for resistance to the IAC isolate of *P. sorghi*, using a seedling screening technique, during 1989–91.

The seedlings were spray-inoculated with a conidial suspension (6×10^5 conidia mL^{-1}) of *P. sorghi* when the plumules had just emerged above the soil level in pots (Reddy et al. 1992). The accessions that remained free from downy mildew, or recorded less than 10% disease incidence in this preliminary screening, were evaluated three more times to minimize the chances of escape, using the same inoculation technique. IS 18433 (DMS 652) was used as the susceptible control and IS 18757 (QL 3) was used as the resistant control. Data from the three screenings were analyzed employing pooled analysis to determine the homogeneity of error variances in the resistance levels of the accessions.

Among the 2707 germplasm accessions initially evaluated, 35 were identified as resistant (≤5% downy

Table 1. Mean downy mildew incidence (%) in 35 sorghum accessions tested under greenhouse conditions at ICRISAT Asia Center during 1989–91.

Genotype	Origin	Race[1]	Plant height (cm)	Grain color[2]	Downy mildew (%) Mean[3]	Downy mildew (%) Maximum
IS 20454	Niger	D	300	W	0.0	0.0
IS 20468	Niger	D	345	W	0.0	0.0
IS 20478	Niger	DC	325	LR	0.0	0.0
IS 20655	USA	G	305	S	0.0	0.0
IS 23036	Sudan	B	350	LB	0.0	0.0
IS 23855	Yemen	CB	380	RB	0.0	0.0
IS 23884	Yemen	CB	380	RB	0.0	0.0
IS 23836	Yemen	D	385	W	0.0	0.0
IS 23948	Yemen	CB	380	RB	0.0	0.0
IS 23966	Yemen	DC	340	RB	0.0	0.0
IS 22227	Australia	C	100	R	0.0	0.0
IS 22228	Australia	C	120	R	0.0	0.0
IS 22229	Australia	GC	115	R	0.0	0.0
IS 22230	Australia	CB	135	R	0.0	0.0
IS 20473	Niger	DB	350	W	0.3	1.0
IS 20455	Niger	DB	295	LR	0.3	1.0
IS 20653	USA	B	260	S	0.4	1.1
IS 23838	Yemen	CB	430	RB	0.7	2.0
IS 20704	USA	G	300	R	0.7	2.0
IS 22620	Cameroon	C	320	B	0.7	2.0
IS 20467	Niger	DB	295	LR	0.9	1.7
IS 20651	USA	B	270	S	1.0	1.0
IS 20418	Niger	D	360	S	1.0	3.0
IS 20452	Niger	D	315	LR	1.3	3.0
IS 20450	Niger	D	260	LR	1.4	2.0
IS 19082	Sudan	GC	205	S	4.0	5.0
IS 20405	Niger	D	400	LR	2.6	5.0
IS 20482	Niger	D	380	LR	2.6	6.5
IS 19007	Sudan	D	290	LR	2.6	5.0
IS 23786	Malawi	CB	320	B	3.0	6.2
IS 22111	India	D	390	LR	4.1	11.3
IS 20456	Niger	D	310	W	4.3	5.7
IS 20408	Niger	DC	315	R	4.3	9.0
IS 25141	Ethiopia	D	255	S	5.4	12.0
IS 23903	Yemen	CB	340	RB	8.1	23.9
IS 18757 (Resistant control)	Australia	CB	130	LR	0.0	0.0
IS 18433 (Susceptible control)	India	DC	120	S	98.3	99.0
SE for experimental runs (E)					±0.09	
SE for accessions (A)					±0.66	
SE for E × A					±1.14	

1. B = Bicolor, C = Caudatum, D = Durra, G = Guinea, CB = Caudatum bicolor, DC = Durra caudatum, GC = Guinea-caudatum, and DB = Durra bicolor.
2. R = Red, B = Brown, W = White, S = Straw, LR = Light red, LB = Light brown, and RB = Reddish brown.
3. Mean of three experimental runs.

Table 2. Analysis of variance for downy mildew incidence (%) of 37 sorghum accessions in three experimental runs in the greenhouse at ICRISAT Asia Center, India, during 1990.

Source of variation	Degrees of freedom	MS
Experimental runs (E)	2	99.30***
Replications	3	1.54
Accessions (A)	36	3094.28***
Main plot error	108	5.22
A × E	72	32.64***
Subplot error	222	5.15

*** significant at $P = <0.001$.

mildew incidence). Resistance of 33 of these 35 accessions was confirmed in three subsequent screenings (Table 1). Fourteen of these (IS 20454, IS 20468, IS 20478, IS 20655, IS 22227, IS 22228, IS 22229, IS 22230, IS 23036, IS 23836, IS 23855, IS 23884, IS 23948 and IS 23966) remained disease-free and in 19 more, the mean downy mildew incidence was 5% or less. Analysis of variance of incidence of downy mildew showed highly significant effects of accessions (A), experimental runs (E), and their interactions. However, variation was larger between the accessions compared to that between experimental runs or between the interactions (Table 2). Plant height of these 33 resistant accessions varied from 100 cm (IS 22227) to 430 cm (IS 23838). Of these 33, five accessions (IS 20454, IS 20456, IS 20468, IS 20473, and IS 23836) produce white seeds and the rest produce colored seeds. These newly identified sources of resistance to sorghum downy mildew provide plant breeders a broader range of grain colors, plant heights, and races from which to choose resistant parents. This should facilitate breeding of resistant cultivars.

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