Evaluation of Sorghum Lines for Multiple Disease Resistance in India

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Abstract

Resistance to several diseases is desirable in a cultivar for its successful cultivation in farmers' fields where several diseases may occur together. A set of 27 sorghum accessions/breeding lines possessing resistance to individual diseases were evaluated between 1984 and 1987 at Dharwar and Mysore (Karnataka) for downy mildew (DM), Patancheru, ICRISAT Asia Center (Andhra Pradesh) and Bhavanisagar (Tamil Nadu) for grain mold (GM), Dharwar for rust (RU), Udaipur (Rajasthan) for grey leaf spot (GL), and Pantnagar (Uttar Pradesh) for anthracnose (AN), zonate leaf spot (ZL) and GL. IS 8283 and IS 8607 were resistant to all the six diseases; IS 3547, IS 8185 and M 35610 resistant to four diseases; IS 3443, IS 3546, IS 14332, IS 14387, and IS 22227 resistant to three diseases and 13 genotypes were resistant to two diseases at all the locations. Some of these accessions are being used in crossing programs to breed for multiple disease resistance.

कृषक के खेत में जहाँ कई रोग लग सकते हैं फसल की सफल कृषि के लिए किसी भी कृषिजोपजाति में कई रोगों के लिए प्रतिरोधी क्षमता होना वांछित होता है। ज्वार की 27 एक्सेसीयोन्स प्रजनन पंक्तियों के एक समूह जिनमें किसी एक रोग विशेष के प्रतिरोधि क्षमता थी का 1984 और 1987 के मध्य धारवाड़ और मैसूर (कर्नाटक) में मृदुरोमिल आसिता (डी एम), पटेनचेरू, इक्रीसेट एसिया सेन्टर, (आन्ध्र प्रदेश) और भवानी सागर (तमिल नाडु) अनाज मौल्ड (जी एम), धारवाड़ रोली (आर यू), उदयपुर (राजस्थान) घूसर पत्ती धब्बा (जी एल) और पन्तनगर (उत्तर प्रदेश) एन्थ्रैनोज (ए एन), जोनेट पत्ती धब्बा (जेड़ एल) व जी एल. के लए आंकलन किया गया। IS 8283 और IS 8607 सभी6 रोगों के लिए प्रतिरोधी पाई गई। IS3547, IS 8185 और M-35610, 4 रोगों के लिए प्रतिरोधी पाई गई। IS3443, IS3546, Is-14332, IS14387 और 22277 तीन रोगों से प्रतिरोधी पाई गई और 13 जीन प्ररुप सभी स्थानों पर 2 रोगों से प्रतिरोधी मिले। इनमें सेकुछ एक्सेसीयन्स का उपयोग बहु रोग प्रतिरोध क्षमता प्राप्त करने के लिए प्रजनन हेतु संकरण कार्यक्रमों में किया जा रहा है।

Sorghum (*Sorghum bicolor* L. Moench), an important grain and fodder crop, is subject to several diseases that reduce the grain and stover yields. The major fungal diseases of sorghum in India are grain mold caused by a complex of fungi including *Fusarium moniliforme* Sheld., *F. pallidoroseum*, *Curvularia lunata* (Wakker) Boedijn, *Phoma sorghina*, (Sacc.) downy mildew (*Peronosclerospora sorghi*) C.G. Shaw, anthracnose (*Colletotrichum graminicola* (Cesati) Wilson), rust (*Puccinia purpurea* Cooke), grey leaf spot (*Cercospora sorghi*) Ellis & Eve. and zonate leaf spot (*Gleocercospora sorghi* Ban & Edgerton). In sorghum crop grown by farmers under marginal rainfed conditions, control measures other than the use of resistant cultivars may not be economically feasible. Efforts have been made by earlier researchers to identify sources of stable resistance sources to more than one

diseases through International Disease Nurseries (Williams, *et al.*, 1980; Anahosur and Lakshman, 1986). Anahosur (1992) reviewed the distribution of sorghum diseases in India and identified sorghum lines possessing resistance to more than one diseases under natural infection conditions. During 1981-83, a large number of sorghum accessions and breeding lines were screened using artificial inoculation to individual pathogens in disease endemic areas (Mughogho *et al.*, 1987). From these evaluations, genotypes with resistance to individual diseases were pooled during 1984 to form a Sorghum Multiple Disease Resistant Nursery (SMDRN) trials and tested at different locations in India to identify sorghum genotypes resistant to more than one diseases.

Material and Methods

Test entries and locations. Twenty-seven sorghum germplasm and breeding lines were identified as resistant to individual diseases under field screening at ICRISAT Asia Center (IAC) were combined into a trial. This material was evaluated at six locations (hot spots) where conditions were favorable for the expression of one or more sorghum diseases. These locations were: Mysore and Dharwar for downy mildew; Patancheru IAC and Bhavanisagar for grain mold; Dharwar for rust; Udaipur for grey leaf spot; and Pantnagar for anthracnose, zonate leaf spot and grey leaf spot diseases. Evaluations were made during 1984-87 rainy seasons. Seeds of the test entries and susceptible checks to downy mildew, grain mold and the foliar diseases were assembled and multiplied at Patancheru, IAC. Each year, the trials were organized from IAC and seeds were dispatched to each location for testing. A complete randomized experimental design was used. There were two replications of each accessions. Each plot consisted of two 4 m row and 0.75 m within row spacing. Agronomic practices and disease assesment methods were standardized for all locations.

Screening. The infector-row technique was used to evaluate resistance to sorghum downy mildew (Anahosur and Hegde, 1979). Grain mold screening at IAC was conducted using overhead sprinkler irrigation (Bandyopadhyay *et al.*, 1988a). Natural rainfall was relied upon for grain mold screening at Bhavanisagar. Anthracnose resistance was evaluated at Pantnagar using infector row technique (Pande *et al.*, 1994). For other foliar diseases, test entries were evaluated at Dharwar, Udaipur and Pantnagar relying on natural inoculum and infection conditions.

Disease measurement. Downy mildew: Total number of plants and the number of systemically infected plants in each plot were counted 3 weeks after emergence and again at full flowering. Disease was expressed as incidence of infected plants. Grain mold: Five randomly selected panicles from each plot were harvested 14 days after maturity (black layer formation). Each panicle was threshed separately and 50 g of the threshed grain was placed in a petri dish and scored visually for moldiness using a 1-5 scale where, 1 = no mold on grain surface, 2 = < 1% to 10%, 3 = 11 to 25%, 4 = 26 to 50%, and 5 = > 50% of the grain surface molded. Foliar diseases: The foliar diseases were scored at physiological maturity on a 1-5 scale where, 1 = no symptoms, 2 = < 1% to 5%, 3 = 6 to 25%, 4 = 21 to 40%, and 5 = > 40% of the leaf area showing disease symptoms.

Results and Discussion

Sorghum accessions IS 8283 and IS 8607 were resistant to all the six diseases in all years and locations (Table 1). IS 3547 and IS 8185 were resistant to only four diseases - downy mildew, grain mold, anthracnose and rust. Among the breeding lines, M 35610 was resistant to anthracnose, rust, zonate and grey leaf spot; M 36170, SPV 386 and UChV-2 were resistant to anthracnose and rust; and M 36257 to downy mildew and rust. Sorghum accessions that showed resistance to multiple diseases at several locations during 3-4 years of testing (Table 2) are likely to be more stable than those at only one location.

Several sorghum lines were earlier identified with resistance to grain mold at IAC (Bandyopadhyay *et al.*, 1988b), anthracnose (Pande *et al.*, 1994) downy mildew (Karunakar *et al.*, 1994; Narayana *et al.*, 1995), and rust (Singh *et al.*, 1994). Mughogho

Table 1. Average reactions of sorghum germplasm/breeding lines to downy mildew (DM), grain mold (GM), anthracnose (AN), rust (RU), grey leaf spot (GL) and zonate leaf spot (ZL) disease scores at Indian locations during 1984-87

Entry	DM[a]		GM		AN	RU	GL	ZL	
	Dha[b] 4[c]	Mys 4	Pat 4	Bha 4	Pan 4	Dha 4	Pan 3	Uda 3	Pan 4
IS 2204	1(1)[d]	1(4)	2(2)	2(3)	4(5)	4(5)	3(3)	3(4)	4(5)
IS 2473	1(2)	1(3)	2(2)	2(2)	4(5)	4(5)	3(4)	4(4)	3(5)
IS 2474	2(6)	4(17)	2(3)	2(3)	4(4)	5(5)	4(4)	4(5)	4(4)
IS 2482	0(0)	1(4)	2(3)	2(3)	4(4)	5(5)	4(4)	2(2)	4(5)
IS 3443	1(2)	0(0)	3(5)	3(5)	2(2)	1(2)	3(4)	2(2)	3(4)
IS 3546	0(0)	1(2)	2(4)	4(5)	3(4)	2(2)	2(2)	2(2)	3(4)
IS 3547	0(0)	0(0)	3(4)	2(2)	2(2)	1(2)	3(4)	2(2)	4(5)
IS 8185	0(0)	1(1)	2(2)	2(2)	2(2)	2(2)	3(3)	2(2)	3(4)
IS 8219	6(12)	10(15)	2(2)	2(2)	5(5)	4(5)	3(3)	3(4)	4(5)
IS 8283	0(0)	1(1)	2(3)	2(2)	2(2)	2(2)	2(2)	2(2)	2(2)
IS 8607	0(0)	1(1)	2(2)	2(2)	2(2)	2(2)	2(2)	2(2)	2(2)
IS 8614	37(71)	17(27)	2(2)	3(3)	5(5)	4(5)	3(4)	2(2)	4(5)
IS 9482	21(38)	19(49)	2(3)	2(2)	4(5)	4(5)	4(4)	3(5)	4(5)
IS 10710	0(0)	1(2)	2(2)	2(2)	3(4)	4(5)	4(4)	2(2)	3(4)
IS 14332	0(0)	1(2)	2(3)	3(4)	4(4)	2(2)	4(5)	3(4)	4(4)
IS 14375	10(17)	1(2)	2(2)	2(2)	4(5)	2(3)	3(4)	3(3)	3(4)
IS 14387	0(0)	0(0)	2(2)	2(2)	4(5)	2(2)	3(4)	4(5)	3(4)
IS 17141	65(87)	36(40)	2(2)	2(2)	3(5)	2(2)	4(4)	4(5)	3(3)
IS 18757	0(0)	0(0)	3(4)	3(4)	3(5)	3(5)	2(2)	3(3)	3(4)
IS 22227	0(0)	1(1)	2(3)	2(3)	4(5)	4(5)	2(2)	3(3)	3(4)
IS 22229	0(0)	1(2)	3(3)	3(3)	4(5)	4(5)	3(3)	3(3)	5(5)
IS 27042	0(0)	0(0)	4(4)	4(4)	4(4)	3(4)	2(2)	3(4)	3(4)
M 35610	21(64)	13(22)	4(5)	4(5)	2(2)	1(1)	2(2)	2(2)	2(2)
M 36170	39(79)	14(16)	4(5)	3(5)	2(2)	1(1)	4(4)	2(2)	3(4)
M 36257	0(0)	0(0)	4(4)	3(4)	4(4)	1(1)	3(3)	2(2)	4(5)
SPV 386	12(44)	6(12)	4(4)	4(5)	2(2)	2(2)	3(3)	2(3)	3(3)
UChV 2	15(40)	16(30)	4(5)	4(4)	2(2)	2(2)	3(3)	2(2)	2(3)
Susceptible checks									
H 112	81(90)	70(83)	5(5)	5(5)	5(5)	5(5)	4(5)	4(5)	5(5)
DMS 652	95(100)	85(95)	3(4)	3(3)	5(5)	5(5)	5(5)	4(5)	4(5)
SPV 104	4(5)	6(12)	4(5)	5(5)	2(2)	4(5)	3(4)	3(4)	3(3)

[a] Downy mildew (DM) scored as % incidence and grain mold (GH), anthracnose (AN), rust (RU), grey leaf spot (GL) and zonate leaf spot (ZL) scores are based on 1-5 scale, where 1 = Mo disease and 5 = maximum disease.

[b] Locations: Dha = Dharwad (Karnataka), Mys = Mysore (Karnataka), Pat = Patancheru, ICRISAT (Andhra Pradesh), Bha = Bhavanisagar (Tamil Nadu), Pan = Pantnagar (Uttar Pradesh), Uda = Udaipur (Rajasthan)

[c] Numbers of years tested at each location.

[d] Figures in parenthesis indicate the maximum disease scores during 1984-87 at each location.

Table 2. Sorghum accessions resistant to more than one diseases at six locations in India during 1984 to 1987

Entry	Resistant to number of diseases	Diseases[a]
IS 8283	6	DM, GM, AN, RU, ZL, GL
IS 8607	6	DM, GM, AN, RU, ZL, GL
IS 3547	4	DM, GM, AN, RU
IS 8185	4	DM, GM, AN, RU
M 35610	4	AN, RU, ZL, GL
IS 3443	3	DM, AN, RU
IS 3546	3	DM, GL, RU
IS 14332	3	DM, GM, RU
IS 14387	3	DM, GM, RU
IS 22227	3	DM, GM, GL
IS 2204	2	DM, GM
IS 2473	2	DM, GM
IS 2474	2	DM, GM
IS 10710	2	DM, GM
IS 2482	2	DM, GM
IS 14375	2	GM, RU
IS 17141	2	GM, RU
IS 18757	2	DM, GL
IS 27042	2	DM, GL
M 36170	2	AN, RU
SPV 386	2	AN, RU
UChV 2	2	AN, RU
M 36257	2	DM, RU
IS 8219	1	GM
IS 8614	1	GM
IS 9482	1	GM
IS 22229	1	DM

[a]DM = downy mildew, GM = grain mold, AN = anthracnose, RU = rust, ZL = zonate leaf spot and GL = grey leaf spot

et al. (1987) reported sorghum germplasm and breeding lines resistant to more than one diseases. The sorghum lines identified in the present study with resistance to more than one diseases could be of great value to breeding programs with a focus on multiple disease resistance.

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