

# Sorghum pathology: Kharif 2013

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## EXECUTIVE SUMMARY

Pathology programme for the year 2013-14 consisted of applied as well as basic research components. Applied research dealt with multi-location testing of breeding materials for resistance against sorghum diseases at hot spot locations. A total 156 sorghum lines consisting of grain, forage and sweet sorghum entries were evaluated against panicle and foliar diseases in endemic areas (Palem, Coimbatore, Dharwad, Akola, Parbhani, Surat, Udaipur and Pantnagar) spread over three sorghum growing zones. Basic and strategic research focused mainly grain mold, anthracnose and charcoal rot disease.

**Disease situations:** Among panicle diseases grain mold was predominant in Maharashtra, Karnataka, Andhra Pradesh and Gujarat. Sugary disease (ergot) was severe in Gujarat and downy mildew in Karnataka region. Among foliar diseases anthracnose, leaf blight and zonate leaf spot appeared in moderate to severe form in Pantnagar, Udaipur, and Dharwad. Rust was recorded in Dharwad and Udaipur and sporadically in Marathwada region. Sooty stripe was prominent in Vidarbha region. Sporadic incidence of rough, target and grey leaf spots was also noted in Rajasthan, Karnataka and Vidarbha region. In most hot spots centres disease load was optimum as indicated by appearance of disease severity in susceptible checks as well as local checks. Location severity index for various diseases indicated that materials under evaluation exhibited presence of some degree of resistance in them against sorghum diseases.

**Grain mold:** Location severity index (LSI) for grain mold assessed over all the trials in the location indicated that grain mold pressure was moderate in most of the locations and severe in Dharwad and Palem. Grain mold severity ranged from 2.0 to 9.0 with mean 4.0 in grain sorghum (AHT, AVT, IHT and IVT), 2.3 to 7.0 with mean 3.2 in forage sorghum (IVHT and AVT) and 2.3 to 6.1 with mean 3.5 in sweet sorghum (IAVHT). Among advanced grain sorghum entries SPH 702(2), SPH 1736, SPH 1737, SPV 2174, SPV 2179 and SPV 2181 were moderately resistant to grain mold. Most promising entries in initial grain sorghum trials were SPH 1748, SPH 1751, SPV 2246, SPV 2252 and SPV 2254. Promising sweet sorghum entries for grain mold resistance were SPH 1754, SPV 2200, SPV 2241 and SPV 2271. Among forage sorghum entries SPV 2128(2), SPV 2190, SPV 2261, SPV 2263 and SPV 2264 were promising for grain mold resistances.

**Sugary disease:** Four grain sorghum (AHT, AVT, IHT & IVT) and one sweet sorghum (IAVHT) trials were evaluated for sugary disease (ergot) resistance in hot spots. During kharif 2013 moderate incidence appeared in Surat. Location severity index (LSI) for ergot indicated that disease severity in Surat was 18.6%. Ergot severity ranged from 8.0 - 40% with mean 18.1% in grain sorghum and 10.4 to 28.5 with mean 19.1% in sweet sorghum. Among grain sorghum entry the hybrids SPH 1731 and SPH 1748 and the varieties SPV 2179, SPV 2182, SPV 2183, and SPV 2246 were resistant to ergot. Among sweet sorghum entries SPV 2195, SPV 2196 and SPV 2271 [range, 10.4 to 13.8%] were promising for ergot resistance.

**Downy mildew:** Eighty grain sorghum entries consisting of four trials (AHT, AVT, IHT & IVT) were evaluated for downy mildew resistance in endemic locations. Location severity index indicated that downy mildew severity was severe in Dharwad (LSI, 71.1) and sporadic in Coimbatore (LSI, 3.4). In other locations there was no report of downy mildew incidence during this season. At Dharwad disease incidence ranged from 0% (QL3) to 100% (DMS 652) indicating resistant to susceptible disease reactions. Because of severe incidence only two entries *viz.*, SPH 1702 (2) and CSH 25 recorded downy mildew  $\leq 25\%$ . None of the entries was resistant this season at Dharwad location.

**Foliar diseases:** Anthracnose, leaf blight and zonate leaf spot remained major foliar diseases during kharif 2013. Location severity index for foliar diseases suggested that anthracnose severity was moderate to high at Pantnagar and Surat and low at Udaipur and Coimbatore. Zonate leaf spot was moderate at Udaipur, Pantnagar, Coimbatore, Dharwad and Surat. Leaf blight was moderate at Surat and low to moderate at Udaipur, Coimbatore and Parbhani. Rust was sporadic at Dharwad, Parbhani and Coimbatore. Other foliar diseases like rough, gray leaf spot and sooty stripe in Akola, target leaf spot in Udaipur and grey leaf spot in Parbhani was recorded in low to moderate form. Most promising entries for foliar disease resistance were as follows; Grain sorghum hybrid- SPH 1703 (2), SPH 1705 (2), SPH 1748, SPH 1749, SPH 1751; varieties- SPV 1822(2), SPV 2122(2), SPV 2183, SPV 2244, SPV 2247, SPV 2248. Forage hybrid- SPH 1753, SPH 2242; varieties- SPV 2128(2), SPV 2259, SPV 2261, SPV 2262, SPV 2264 and sweet sorghum hybrid- SPH 1755; varieties SPV 2205, SPV 2241, SPV 2268.

**Multiple resistances:** Few entries showed resistance to more than two diseases. In grain sorghum combined resistance against grain mold and downy mildew, grain mold and ergot and grain mold and foliar diseases are required for different growing situations. SPH 1702 (2) was moderately resistant to grain mold and downy mildew, SPH 1748, SPV 2179, SPV 2246 and SPV 2271 were resistant to grain mold and ergot. Sweet sorghum variety SPV 2205, and SPV 2241 and forage varieties SPV 2128 (2), SPV 2261 and SPV 2264 were resistant to grain mold and foliar diseases (anthracnose and zonate leaf spot). For forage varieties leaf disease resistance is of utmost importance. In multi-cut forage hybrid SPH 1753 and SPH 2242, there was combined resistance against anthracnose, zonate leaf spot and leaf blight. In single cut forage SPV 2128(2), SPV 22259, SPV 2261 and SPV 2262 there was combined resistance against anthracnose, zonate leaf spot and leaf blight. Of these, SPV 2128(2) and SPV 2261 also had grain mold resistance combined with multiple foliar disease resistance.

**Anthracnose variability:** Anthracnose pathogen *Colletotrichum graminicola* showed wide variability in their disease causing ability as revealed by disease reactions of ten isolates on ten sorghum genotypes at hot spot location (Pantnagar). Isolate CgD and CgL were highly virulent that could register 8 susceptible reactions out of 10 lines. Isolate CgB and CgS were least virulent of the ten isolates that could register 6 susceptible reactions. Because of high disease pressure variability was narrowed down. None of the isolates could produce susceptible disease reactions on Pant Chari-5 suggesting the line might have adequate resistant to anthracnose. In terms of aggressiveness CgA was the most and CgS was the least aggressive isolate on this set of sorghum lines.

**Grain mold nursery:** Entries SGMRN 12-3-1, R10-MP 13, GMR 156-1 and GMR 166-1 were resistant to grain mold. AKMGR 104, AKMGR 103, GMR 84-2, PSGVS 106, GMR 83-1, SU 1363 and GMR 166-1 recorded less than 20% *Fusarium* and PSGVS 106, GMR 166-1, SGMRN 12-3-1, AKMGR less than 15% *Curvularia* infection.

**Pest and disease resistant nursery:** Out of seven entries four were resistant/ moderately resistant to grain mold (GMR308, GMR156, GMR144-2, GMR309, score<5.0) and others were susceptible. All were resistant to anthracnose but susceptible to downy mildew

**Publications and recognitions:** The group was involved in publishing 13 research articles during 2013 in national (10) and international (3) journals. Twenty abstracts were presented in different symposia at national and international level. Akola centre received the best poster award in international symposium.

## DETAILED REPORT

### 1. Disease situation

The report of the survey conducted on disease incidence in farmers' fields and in research plots at different sorghum growing states in the country is as given below.

**Andhra Pradesh:** During survey it was found that the grain mold incidence was medium in farmer's field since most of the farmers have grown locals and all most all farmers' sowings were taken up in first week of June to avoid the mold problem. There was medium incidence of grain mold in the experimental trails. Incidence of foliar diseases viz., leaf blight anthracnose and rust was low in local varieties. In the experimental plot there was low incidence leaf blight and anthracnose.

**Maharashtra:** In western Maharashtra and Vidarbha region including Amravathi, Buldana, Wasim and Akola district grain mold incidence was moderate to high on local and improved cultivars in farmers' field. Among the foliar disease zonate and grey leaf spot and sooty stripe appeared sporadically on some cultivars. In Marathwada region grain mold incidence was moderate. Moderate incidence of anthracnose and leaf blight and sporadic incidence of zonate and grey leaf spot and rust were noted in farmers' field.

**Karnataka:** In northern districts of Karnataka downy mildew, grain mold, rust and zonate leaf spot, were the major diseases of sorghum. The grain mold score ranged from 2-8. The downy mildew incidence ranged from 0-100% in farmers field with mean incidence of 16.7%. In experimental plot down mildew was 100% in some entries causing extremely poor plant stand. Among the foliar diseases, the rust was low to moderate in farmer's field this season where zonate leaf spot ranged from 2-7 with mean incidence of 3.9.

**Tamil Nadu:** Overall disease incidence was low and grain mold incidence was less. Leaf blight, zonate leaf spot and anthracnose was in low to moderate form. Downy mildew incidence was sporadic during this season.

**Rajasthan:** Periodical surveys have been conducted at two crop growth stages- seedlings and grain formation in the farmers' fields of Udaipur, Chittoregarh, and Rajsamand. Moderate to severe infection of anthracnose, zonate leaf spot and traces to moderate infection of leaf blight and target leaf spot has been observed on local land races of sorghum.

**Uttarakhand:** Disease situation was surveyed in farmers' field in the districts of Dehradun, Nainital, Haridwar and US Nagar on improved and local cultivars. Anthracnose and zonate leaf spot were severe on local than improved cultivars. These two diseases occurred in moderate to severe intensity (grade 5 - 8) in almost all the genotypes grown in farmers' field.

**Gujarat:** Survey work was carried out in the different sorghum growing areas of the state. In south Gujarat, grain mold and sugary disease were observed low to moderate on farmers' field. In experiments, the same were observed with moderate to high intensity. Anthracnose, bacterial leaf blight and zonate leaf spot were low to moderate.

In brief, among panicle diseases grain mold was predominant in Maharashtra, Karnataka, Andhra Pradesh and Gujarat. Sugary disease (ergot) was moderate to severe in Gujarat. Downy mildew was noted in high intensity in Dharwad region. Among foliar diseases anthracnose, leaf blight and zonate leaf spot appeared in moderate to severe form in Pantnagar, Udaipur, and Surat. Rust was recorded in Dharwad and Udaipur and sporadically in Marathwada region of Maharashtra. Sporadic incidence of rough, target and grey leaf spots was also noted in Akola, Udaipur, and Dharwad region. Location severity index (LSI) for various diseases indicated that materials under evaluation exhibited presence of some degree of resistance in them against most of the diseases.

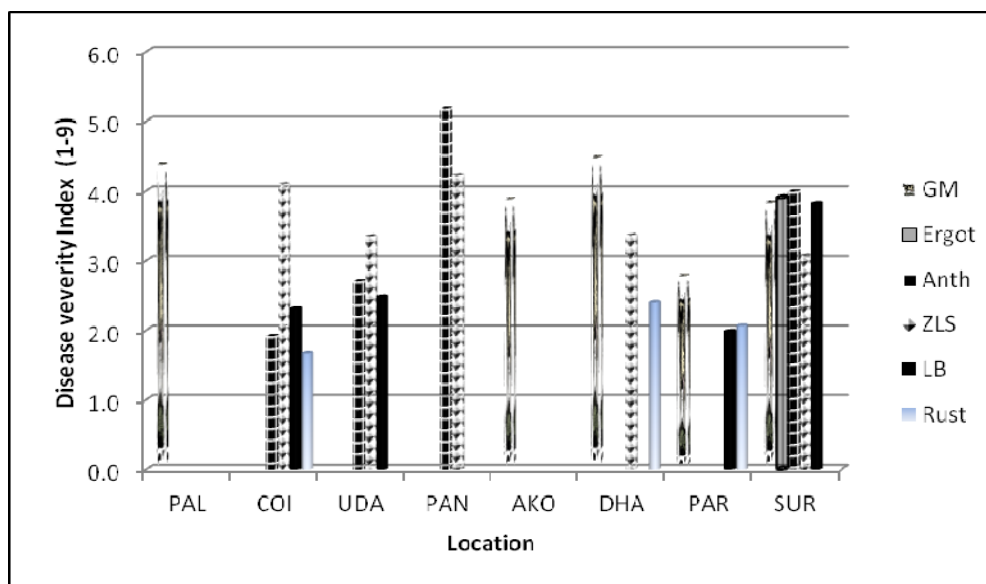


Fig. 1. Disease severity index for different locations during kharif 2013

## 2. Grain mold (*Fusarium* spp, *Curvularia* spp.)

Palem and Coimbatore in Zone I and Akola, Parbhani, Dharwad and Surat in Zone II are hot spots for grain mold. Four grain sorghum, one sweet sorghum and two forage sorghum trials were evaluated for grain mold under natural conditions in hot spots. Panicle grain mold score (PGS) and threshed grain mold score (TGS) were recorded using 1-9 rating scale, where 1 = no mold and 9= >75% mold infected grains in Zone I and Zone II. Location severity index (LSI) for grain mold assessed over all the trials in the location indicated that grain mold pressure was low to moderate across locations. Dharwad recorded the highest (4.5) and Parbhani the lowest (2.8) LSI during kharif 2013-14 (Table S1). Apart from Parbhani, grain mold pressures in all other locations were moderate. Coimbatore centre did not observe notable grain mold incidence this season.

Table S1. Grain mold severity index for different locations (LSI)

Zone	Location	AHT	AVT	IHT	IVT	LSI	Max Score	Total Observations
Zone1	Palem	4.6	4.1	4.9	3.9	4.4	9.0	225
Zone2	Akola	4.4	3.5	3.7	3.9	3.9	6.7	225
	Parbhani	3.4	2.2	3.3	2.2	2.8	5.0	225
	Dharwad	4.5	4.1	4.6	4.7	4.5	6.7	210
	Surat	3.7	3.7	4.2	3.7	3.8	6.3	225
National	India	4.1	3.5	4.1	3.7	3.9	9.0	1110

### Grain sorghum

Grain sorghum entries in four trials (13 in AHT, 20 in AVT, 8 in IHT and 19 in IVT) were evaluated for grain mold resistance under natural conditions in Zone I (Palem & Coimbatore) and Zone II (Akola, Parbhani, Dharwad & Surat).

#### 1.1 Advanced Hybrid Trial (AHT-GS)

AVT-GS trial was comprised of total 18 entries. They included 9 test entries, four hybrid checks, one local check from respective centre and five pathology checks for comparing disease reactions. Grain mold was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II). Location means of grain mold severity were 4.4 (Palem), 4.3 (Akola), 3.4 (Parbhani), 4.2 (Dharwad), and 3.7 (Surat).

Panicle grain mold (PGS): PGS was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II) (Table 1.1). Average data over the locations showed that PGS ranged from 1.0 to 8.8 (resistance to susceptible reaction). Zone-I- Trials were laid at two centres (Coimbatore & Palem) in Zone I. At

Palem, location severity index (LSI) for grain mold was 4.4 where susceptible check scored 9.0. One entry showed resistant, four moderately resistant and four susceptible reactions. The resistant entry was SPH1737 (3.0) and moderately resistant entries were SPH1702 (2), SPH1703 (2), SPH1733, and SPH1736. Coimbatore centre, however, did not observe any grain mold incidence.

#### All India summary results (grain mold)

Trial details	Trial names			
	<i>AHT- GS</i>	<i>AVT- GS</i>	<i>IHT- GS</i>	<i>IVT-GS</i>
Checks				
CSH 16	3.8	-	5.0	-
CSH 23	5.1	-	5.0	-
CHS25	5.1	-	4.6	-
CSH30	5.3	-	3.8	-
CSV17	-	3.2	-	3.6
CSV 20	-	4.2	-	3.4
CSV 23	-	3.6	-	3.8
CSV27	-	3.4	-	2.4
Local check	4.1	3.8	4.7	3.4
B58586 (R)	2.9	1.3	2.3	1.9
296B (S)	6.7	6.2	6.6	6.4
Bulk Y (S)	6.4	6.0	6.4	5.9
Mean	4.7	4.1	4.4	3.8
Minimum	2.9	1.3	2.3	1.9
Maximum	6.7	6.2	6.6	6.4
Five top ranked entries including checks	CSH16, SPH 1736, SPH1737, SPH1724, SPH1731 (3.1 to 3.8]	CSV17, SPV2181, CSV27, CSV23, SPV 2174 [3.2 to 3.8]	SPH 1748, CSH30, SPH 1751, CSH25, SPH 1749 [3.3 to 4.7]	CSV27, SPV 2252, SPV2246, CSV20, SPV2254 [2.4 to 3.5]
Entries on par with best resistant check	NS	SPV2174, 2179, 2181	SPH 1748, 1749, 1751	All except SPV2242 & SPV2245
Entries on par with best hybrid/ varietal check	NS	all	all	all
Locations considered for National average	Palem, Parbhani, Akola, Surat, Dharwad	Palem, Parbhani, Akola, Surat, Dharwad	Palem, Parbhani, Akola, Surat, Dharwad	Palem, Parbhani, Akola, Surat, Dharwad
Comments	No grain mold incidence at Coimbatore			

**Zone II-** In zone II trials were conducted at Parbhani, Akola, Dharwad and Surat. Mold reactions of entries significantly differed at all locations. At Parbhani, location severity index (LSI) for grain mold was 2.8 where susceptible check, Bulk Y scored 5.0 (Table S1). All the nine test entries showed resistant to moderately resistant grain mold reactions ( $\leq 4.3$ ). The local check showed resistant reaction (2.7). At Akola, location severity index (LSI) was 3.9 where susceptible check scored 6.7. Except SPH1705 (2) and SPH1733 all other entries showed resistant to moderate resistance reactions. SPH1724 showed resistance and other six moderate resistances. At Dharwad, location severity index (LSI) was 4.5 where susceptible check scored 6.7. SPH1724 showed resistance comparable to CSH16, the local check and the resistant line B58586. All other entries except SPH1705 (2) and SPH1733 were moderately resistant. Top ranked three entries were SPH1724, SPH1737 and SPH 1702 (2). At Surat, location severity index (LSI) was 3.8 where susceptible check scored 6.3. Three entries showed resistance and other six moderate resistances. Top ranked three entries were SPH1736, SPH1731 and SPH 1703 (2). Considering results from all the above, six centres SPH1724, SPH 1730, SPH 1731, SPH 1736 and SPH 1737 performed better ( $< 4.0$ ) than others in zone II. National- Pooled analysis over locations indicated that the entries SPH1736, SPH1737 performed better than others in both zones ( $\leq 3.6$ ) (Table 1.1).

**Threshed grain mold (TGS):** TGS was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II) (Table 1.1). Average data over the centres indicated that TGS ranged from 1.5 to 6.7 (resistance to susceptible reaction). **Zone I:** At Palem top five entries with less TGS were SPH1737, SPH1703, CSH16, SPH 1736, and SPH1702 (2) [2.8 to 3.8] where susceptible check recorded 8.6 (Table 1.1). **Zone II:** At Parbhani all entries showed susceptible reactions for grain mold. TGS for entries ranged from 5.7 to 8.7 where susceptible check recorded 8.7. At Akola top five entries showed resistant to moderately resistant reactions where susceptible check recorded 6.7. These entries were SPH1724, CSH16, SPH 1703(2), SPH1730, and SPH1737 [3.0 to 4.7]. At Dharwad top five entries with less TGS were SPH1724, CSH16, SPH 1702(2), SPH1736, and SPH1737 [2.7 to 4.0]. At Surat disease pressure was low and location mean was 3.3. Most of the

entries recorded resistant to moderately resistant reactions to grain mold [2.0 to 4.3] where susceptible check recorded 5.0. National: Data from two zones consisting of five centres indicated that SPH1703(2), SPH1736 and SPH1737 were tolerant to grain mold across locations.

**Seed mycoflora:** Seed mycoflora studies were carried out on harvested grains at Palem (Zone I), Parbhani and Akola (Zone II) centres (Table 1.2). Frequency of infection of major grain mold fungi like *Fusarium* and *Curvularia* was estimated along with infection of other fungi. Zone I- At Palem *Fusarium* infection ranged from of 1.6 (B58586) to 40.2% (296B) and *Curvularia* infection from 2.1 (R'local) to 32.6% (296B). Among test entries lowest *Fusarium* and *Curvularia* infection was recorded on SPH1737 in zone I. Zone II- In zone II *Fusarium* infection ranged from of 10.3 (B58586) to 39.9% (296B) and *Curvularia* infection from 16.5 (SPH1731) to 35.5% (Bulk Y). Among the entries SPH1731 recorded lowest *Fusarium* and *Curvularia* infection on mature grain followed by SPH1737. National- Data from two zones consisting of five centres indicated that SPH1737 was least affected by seed borne infection by of *Fusarium* and *Curvularia*. Based on results of PGS, TGS and seed mycoflora studies SPH1736 and SPH1737 were found promising for grain mold resistance.

### 1.2 Advanced Varietal Trial (AVT-GS)

Number of total entries in AVT-GS was 25. They included 16 test entries, four varietal checks, one local check from respective centre and four pathology checks for comparing disease reactions. Grain mold was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II). Location means of grain mold severity were 4.0 (Palem), 3.5 (Akola), 2.1 (Parbhani), 4.0 (Dharwad), and 3.7 (Surat).

**Panicle grain mold:** PGS was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II) (Table 2.1). This season Coimbatore centre did not observe notable grain mold incidence. Average data over the locations showed that PGS ranged from 1.0 to 8.8 (resistance to susceptible reaction). Zone-I- Trial was laid at two centres (Coimbatore & Palem) in Zone I. At Palem, location severity index (LSI) for grain mold was 4.4 where susceptible check scored 9.0. Two entries showed resistant, and rest were moderately resistant at Palem. The resistant entries were SPV2179 (2.7) and SPV2181 (3.0). Zone II- In zone II trials were conducted at Parbhani, Akola, Dharwad and Surat. Mold reactions of entries significantly differed at all locations. At Parbhani, disease pressure was low (LSI=2.8) (Table S1) where susceptible check, Bulk Y scored 5.0. In all other location disease pressure was moderate. At Akola, location severity index (LSI) was 3.9 where susceptible check scored 6.7 (Table S1). All entries showed resistant to moderate resistance reactions. SPV2122 (2), SPV2174, SPV2175, SPV2179, SPV2114 (2), SPV2181, and SPV2183 showed resistant reactions. At Dharwad, location severity index (LSI) was 4.5 where susceptible check scored 6.7. SPV2165 showed resistant and others moderately resistant reactions to grain mold. Top ranked three test entries were SPV2165, SPV2114 (2), and SPV2170. At Surat, location severity index (LSI) was 3.8 where susceptible check scored 6.3. Six entries showed resistant and others moderately resistant reactions. Top ranked three entries were SPV2164, SPV2181, and SPV1822 (2). Considering results from the above, three centres SPV2174, SPV2181, and SPV2184 performed better (<3.4) than others in zone II. National- Pooled analysis over locations showed SPV2181, SPV2179, SPV2164, and SPV2174 as promising for panicle grain mold resistance across zones ( $\leq 3.5$ ) (Table 2.1).

**Threshed grain mold:** TGS was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II) (Table 2.1). TGS ranged from 1.3 to 6.2 (resistance to susceptible reaction) over the centres. Zone I: At Palem top five entries with less TGS were SPV2179, SPV2181, CSV17, CSV20, and SPV2178 [2.4 to 3.4] where susceptible check recorded 8.6. Zone II: At Parbhani TGS ranged from 2.0 to 6.7 where susceptible check recorded 5.7. Test entries SPV2181, SPV2164, SPV2174, SPV2182, showed moderately resistant reactions for TGS (<5.0). At Akola SPV2174, SPV2179, and CSV27 showed resistant and others showed moderately resistant TGS where susceptible check recorded 7.0. At Dharwad only SPV2165 showed resistant TGS and others were moderately resistant [range 3.0 to 5.0]. At Surat disease pressure was low and most of the entries recorded resistant to moderately resistant reactions to TGS [2.3 to 5.0] where susceptible check recorded 5.3. National: Data from two zones consisting of five centres indicated that SPV2181 was promising for TGS resistant across locations.

**Seed mycoflora:** Seed mycoflora studies were carried out on harvested grains at Palem (Zone I), Parbhani and Akola (Zone II) centres (Table 2.2). Frequency of infection of major grain mold fungi like *Fusarium* and *Curvularia* was estimated along with infection of other fungi. Zone I- At Palem *Fusarium* infection ranged from of 2.0



(B58586) to 40.0% (296B) and *Curvularia* infection from 2.0 (B58586) to 33.0% (296B). Among test entries least *Fusarium* and *Curvularia* infection was recorded on SPV2179 and SPV2181 in zone I. Zone II- In zone II *Fusarium* infection ranged from of 13.0 (R'local) to 34.0% (SPV2170) and *Curvularia* infection from 13.0 (SPV1774) to 29.5% (296B). Among the entries SPV2114 (2) recorded lowest *Fusarium* (16%) and SPV2174 lowest *Curvularia* (13%) infection on mature grain. National- Data from two zones consisting of five centres indicated that SPV2179, SPV2181, and SPV2174 were least affected by seed borne infection by of *Fusarium* and *Curvularia* in comparison to other entries. Based on results of PGS, TGS and seed mycoflora studies SPV2179, SPV2181, and SPV2174 were found promising for grain mold resistance.

### 1.3 Initial Hybrid Trial (IHT-GS)

Number of total entries in IHT-GS was 13. They included four test entries, four hybrid checks, one local check from respective centre and four pathology checks for comparing disease reactions. Grain mold was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II). Location means of grain mold severity were 4.6 (Palem), 3.7 (Akola), 2.9 (Parbhani), 4.0 (Dharwad), and 4.1 (Surat).

Panicle grain mold: PGS was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II) (Table 3.1). This season Coimbatore centre did not observe notable grain mold incidence. PGS ranged from 1.0 to 9.0 (resistance to susceptible reaction) across locations.

Zone I- Trial was laid at two centres (Coimbatore & Palem) in Zone I. At Palem, location severity index (LSI) for grain mold was 4.4 where susceptible check scored 9.0. Four entries were moderately resistant (SPH1751, SPH1748, CSH30 and CSH23; PGS<5.0) and rest were susceptible at Palem. Zone II- In zone II trials were conducted at Parbhani, Akola, Dharwad and Surat. At Parbhani, disease pressure was low (LSI=2.8) (Table S1) where susceptible check, Bulk Y scored 5.0. In all other location disease pressure was moderate. At Akola, location severity index (LSI) was 3.9 where susceptible check scored 6.7 (Table S1). All entries showed resistant to moderate resistance reactions. SPH1748, SPH1749, CSH25 and CSH30 were resistant (PGS ≤3.0). At Dharwad, location severity index (LSI) was 4.5 where susceptible check scored 6.7. Entries showed moderately resistant to susceptible reactions to grain mold. SPH1748, SPH1751 scored <3.7. At Surat, location severity index (LSI) was 3.8 where susceptible check scored 6.3. SPH1748, SPH1751 scored <3.7. Considering results from the above centres SPH1748, SPH1751, AND SPH1749 performed better (<3.9) than others in zone II. National- Pooled analysis over locations showed SPH1748, SPH1751 as promising for panicle grain mold resistance across zones (≤3.5) (Table 3.1).

Threshed grain mold: TGS was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II) (Table 3.1). TGS ranged from 1.8 to 6.6 (resistance to susceptible reaction) over the centres. Zone I: At Palem out of four test entries three were moderately resistant and one susceptible (SPH1750) where susceptible check recorded 9.0. Zone II: At Parbhani TGS ranged from 1.3 to 6.0 where susceptible check recorded 7.7. Entries SPH1748, CSH16, CSH25 and CSH30 showed moderately resistant reactions for TGS (<5.0). At Akola SPH1748 showed resistant and others showed moderately resistant TGS, where susceptible check recorded 7.3. At Dharwad SPH1748 and SPH1751 showed moderately resistant TGS and others test entries were susceptible [TGS>5.3]. At Surat disease pressure was low and SPH1748 recorded resistant and other three test entries were moderately resistant reactions to TGS [3.3 to 4.7] where susceptible check recorded 6.0. National: Data from two zones consisting of five centres indicated that SPH1748 was promising for TGS resistant across locations.

Seed mycoflora: Seed mycoflora studies were carried out on harvested grains at Palem (Zone I), Parbhani and Akola (Zone II) centres (Table 3.2). Frequency of infection of major grain mold fungi like *Fusarium* and *Curvularia* was estimated along with infection of other fungi. Zone I- At Palem *Fusarium* infection ranged from of 2.0 (B58586) to 40.0% (296B) and *Curvularia* infection from 2.0 (B58586) to 33.0% (296B). Among test entries least *Fusarium* and *Curvularia* infection was recorded on SPH1748 and SPH1751 in zone I. Zone II- In zone II *Fusarium* infection ranged from of 19.0 (R'local) to 44.0% (Bulk Y) and *Curvularia* infection from 20.0 (R'local) to 29.0% (SPH1750). Among the entries SPH1748 recorded lowest *Fusarium* (23%) and *Curvularia* (21%) infection on mature grain. National- Data from two zones consisting of five centres indicated that SPH1748 and SPH1751 were least affected by seed borne infection by *Fusarium* and *Curvularia* in comparison to other entries. Based on results of PGS, TGS and seed mycoflora studies SPH1748 and SPH1751 were found promising for grain mold resistance.

#### 1.4 Initial Varietal Trial (IVT-GS)

Number of total entries in IVT-GS was 24. They included 15 test entries, four varietal checks, one local check from respective centre and four pathology checks for comparing disease reactions. Grain mold was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II). Location means of grain mold severity were 3.8 (Palem), 3.8 (Akola), 2.0 (Parbhani), 4.7 (Dharwad), and 3.7 (Surat).

**Panicle grain mold:** PGS was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II) (Table 4.1). PGS ranged from 1.0 to 9.0 (resistance to susceptible reaction) across locations. Zone I- Trial was laid at two centres (Coimbatore & Palem) in Zone I. At Coimbatore incidence was minor. At Palem, location severity index (LSI) for grain mold was 4.4 where susceptible check scored 9.0. Four entries were resistant (SPV2247, SPV2252, SPV2255, SPV2256, PGS $\leq$ 3.0) and rest were moderately resistant (except SPV2245, susceptible). Zone II- In zone II trials were conducted at Parbhani, Akola, Dharwad and Surat. At Parbhani, disease pressure was low (LSI=2.8) (Table S1) where susceptible check, Bulk Y scored 5.0. In all other location disease pressure was moderate. At Akola, location severity index (LSI) was 3.9 where susceptible check scored 6.0 (Table S1). All entries (except SPV2245) showed resistant to moderate resistance reactions. Entries SPV2246, SPV2249 and SPV2254 were resistant (PGS  $\leq$ 3.0). At Dharwad, location severity index (LSI) was 4.5 where susceptible check scored 6.7. Entries showed moderately resistant to susceptible reactions. Moderately resistant entries were SPV2243, SPV2250, SPV2252, SPV2254, SPV2255, SPV2256 (PGS $<$ 5.0). At Surat, location severity index (LSI) was 3.8 where susceptible check scored 6.3. SPV2243, SPV2244, SPV2247 and SPV2254 scored  $<$ 3.0. Considering results from the above centres SPV2252, SPV2254 and SPV2256 performed better ( $<$ 3.5) than others in zone II. National- Pooled analysis over locations showed SPV2252 and SPV2254 as most promising for panicle grain mold resistance across zones ( $\leq$ 3.1) (Table 4.1).

**Threshed grain mold:** TGS was recorded at five centres namely Palem (Zone I), Akola, Parbhani, Dharwad & Surat (Zone II) (Table 4.1). Score ranged from 1.7 to 9.0 (resistance to susceptible reaction) over the centres. Zone I: Top five entries were SPV2246, SPV2247, SPV2252, SPV2255 and SPV2256 (TGS $\leq$ 3.0), where susceptible check recorded 9.0. Zone II: At Parbhani TGS ranged from 1.0 to 4.3 where susceptible check recorded 6.0. Top five entries were SPV2249, CSV20, CSV27, SPV2246 and SPV2247. At Akola SPV2249 and CSV17 showed resistant and others showed moderately resistant, where susceptible check recorded 7.3. At Dharwad SPV2250, SPV2254, SPV2255 and SPV2256 showed moderate resistance [TGS $<$ 5.0]. At Surat to five entries were SPV2243, SPV2244, SPV2247, SPV2253, SPV2254 and CSV17. National: Data from two zones consisting of five centres indicated that SPV2246 and SPV2252 were promising for TGS resistant across locations.

**Seed mycoflora:** Seed mycoflora studies were carried out on harvested grains at Palem (Zone I), Parbhani and Akola (Zone II) centres (Table 4.2). Frequency of infection of major grain mold fungi like *Fusarium* and *Curvularia* was estimated along with infection of other fungi. Zone I- At Palem *Fusarium* infection ranged from of 2.0 (B58586) to 40.0% (296B) and *Curvularia* infection from 2.0 (B58586) to 33.0% (296B). Among test entries least *Fusarium* and *Curvularia* infection was recorded on SPV2246, SPV2247, SPV2255 and, SPV2256. Zone II- In zone II *Fusarium* infection ranged from of 12.0 (B58586) to 30.0% (296B) and *Curvularia* infection from 13.0 (SPV2248) to 34.0% (BulkY). National- Data from two zones consisting of five centres indicated that SPV2248 and SPV2256 were least affected by seed borne infection by *Fusarium* and *Curvularia* in comparison to other entries. Based on results of PGS, TGS and seed mycoflora studies SPV2252 was found most promising for grain mold resistance.

#### *Forage sorghum*

One trials of multi cut forage (IAHT-MC) and two trials of single cut forage (AVT-SC, and IVT-SC) were conducted during kharif 2013. Multi-cut trial was conducted at Coimbatore, Udaipur, Pantnagar (Zone I) and Akola and Surat (Zone II). Single-cut trials were conducted at Palem, Coimbatore, Udaipur, Pantnagar (Zone I) and Parbhani, Akola and Surat (Zone II). Panicle grain mold rating was done using 1-9 rating scale in grain mold prone locations.

### All India summary results (grain mold)

Trial details	Trial names	
	AVT- SC	IVHT- SC
Checks		
CSV 21F	3.7	4.0
HC 308	2.3	3.0
Local check	3.3	5.0
Pant Chari	3.0	7.0
Bulk Y (S)	3.0	2.3
Mean	3.3	4.0
Minimum	2.3	2.0
Maximum	4.3	7.0
Three top ranked entries	HC 308, SPV2128(2),SPV2190 [2.3 to 3.3]	SPV2261, SPV2263, SPV2264 [2.0 to 3.0]
Entries on par with best varietal check	All except SPV2185	All
Locations considered for National Av.	Akola	Akola
Comments	Low to moderate disease pressure in these locations for grain mold	

#### 1.5 Initial Varietal & Hybrid Trial (Single cut)

Grain mold observations on IVHT single cut forage trials were reported from Akola and Parbhani (Zone II). Incidence was minor in Parbhani while Coimbatore and Surat centre did not report about it. The trial consisted of 19 entries including three checks HC 308, CSH27 and CSV 21 F with one local check. B58586 and Bulk Y were used as grain mold resistant and susceptible checks. At Akola grain mold incidence on IVHT entries was low to moderate. All the entries showed resistant to moderate resistant reactions. Location mean was 3.3 and 4.0 for PGS and TGS respectively. Susceptible check did not show enough disease pressure so the other entries could be compared (Table 5.1).

#### 1.6 Advanced Varietal Trial (Single cut)

Grain mold observations on AVT single cut forage trials were reported from Akola and Parbhani (Zone II). Incidence was minor in Parbhani while Coimbatore and Surat centre did not report about it. The trial consisted of 13 entries including three checks HC 308, CSV 21 F and CSV 21 F(1) and one local check. Grain mold resistant (B58586) and susceptible (Bulk Y) checks were used. At Akola incidence was low and all the entries showed resistant to moderate resistant reactions. Location mean was 3.0 and 3.3 for PGS and TGS respectively. Susceptible check did not show enough disease pressure so the other entries could be compared (Table 6.1).

#### 1.7 Initial & Advance Varietal & Hybrid Trial (Multi cut)

The trial consisted of 12 test entries including three checks SSG 59-3, CSH 20MF and CSH 24MF and one and local check. Grain mold is not considered important for multi-cut forage as vegetative part is the main product.

#### *Sweet sorghum*

Sixteen genotypes including 3 checks and one local check were evaluated at Palem (Zone I), Parbhani, Akola and Surat (Zone II) against grain mold. Panicle grain mold rating was scored at all the centres and threshed grain mold rating was recorded at Akola and Surat (Table 8.1).

#### 1.8 Initial & Advanced Varietal & Hybrid Trial

Twenty genotypes including 3 checks and one local check were evaluated for grain mold. Four pathology checks were used for comparing disease reactions. Grain mold was recorded at four centres namely Palem (Zone I), Akola, Parbhani, & Surat (Zone II). Incidence at Palem and Parbhani were sporadic and low hence not considered for analysis. Location means of grain mold severity were 3.7 (Akola), and 3.4 (Surat).

### All India summary result (grain mold)

Trial details	Trial names
	IAVHT- SS
Checks	
CSH 22SS	3.3
CSV 19SS	4.5

Trial details	Trial names
CSV 24SS	3.0
B58586 (R)	3.8
296B (S)	4.8
Mean	3.5
Minimum	2.7
Maximum	5.0
Three top ranked entries	SPV 2241, SPV 2271, SPV 2200, SPV2267 [2.7 to 3.0]
Locations considered	Akola, Surat
Comments	Low to moderate disease pressure in these locations for grain mold

**Panicle grain mold:** Average data over the locations showed that PGS ranged from 2.3 to 6.0 (resistance to susceptible reaction) (Table 8.1). Mold reactions of entries significantly differed at both locations. At Akola, location severity index (LSI) was 3.9 where susceptible check scored 6.7 (Table S1). All entries showed resistant to moderate resistance reactions. SPV2241, SPV2268, SPV2271 and CSV24SS showed resistant reactions. At Surat, location severity index (LSI) was 3.8 where susceptible check scored 6.3. Top ranked three entries were SPV2200, SPV2241 and SPV2271. Considering results from the above centres, SPV2241 and SPV2271 performed better (<3.3) than others in this zone. National- Pooled analysis over locations showed SPV2241, SPV2200 as promising for panicle grain mold resistance across zones ( $\leq 3.0$ ) (Table 8.1).

**Threshed grain mold:** TGS ranged from 2.3 to 6.0 (resistance to susceptible reaction) over the centres (Table 8.1). At Akola SPV2241 and SPV2268 showed resistant and others showed moderately resistant TGS, where maximum score was 6.0. At Surat disease pressure was low and most of the entries recorded resistant to moderately resistant reactions [2.0 to 5.0] where susceptible check recorded 5.3. National: Data from two zones consisting of five centres indicated that SPV2200, SPV2241 and SPV2271 were promising across locations.

**Seed mycoflora:** Seed mycoflora studies were carried out on harvested grains at Parbhani and Akola (Zone II) centres (Table 8.2). Frequency of infection of major grain mold fungi like *Fusarium* and *Curvularia* was estimated along with infection of other fungi. In zone II *Fusarium* infection ranged from of 26.0 (SPV2268) to 35.0% (296B) and *Curvularia* infection from 14.0 (R'local) to 24.7% (SPV2269). Among the entries SPV2241 and SPV2267 recorded lowest *Fusarium* (<27%) and *Curvularia* (<16%) infection on mature grain. National- Based on results of PGS, TGS and seed mycoflora studies SPV2200 and SPV2241 were promising for grain mold resistance.

### 3. Ergot (*Claviceps sorghi*)

Ergot or sugary diseases is an important panicle disease affection seed production in sorghum. Four grain sorghum, one sweet sorghum trials were evaluated for ergot resistance under natural conditions. During kharif 2013 the disease was reported from Surat centre. Location severity index (LSI) for ergot assessed over all the trials in the location indicated that disease severity was moderate in Surat (LSI 18.6%) (Table S2). The disease was not, however, reported from other locations including Coimbatore, Palem, Dharwad, Akola and Parbhani during this season.

Table S2. Ergot severity index for different trials (%)

Location	AHT	AVT	IHT	IVT	IAVHT-SS	LSI	Min Score	Max Score	Total Entry
SURAT	19.2	17.4	22.6	16.6	19.1	18.6	8.0	40.0	103

### *Grain sorghum*

Grain sorghum entries in four trials (13 in AHT, 20 in AVT, 8 in IHT and 19 in IVT) were evaluated for ergot resistance under natural conditions in Zone I (Palem & Coimbatore) and Zone II (Akola, Parbhani, Dharwad & Surat). Incidence of ergot was recorded in percentage (where, up to 10% resistant; 11-30% moderately resistant; 31-50% susceptible; and >50% highly susceptible). During this season only Surat centre experienced the disease and there was no report of incidence of ergot in other locations on grain and sweet sorghum test entries.

### All India summary results (Ergot)

Trial details	Trial names			
	<i>AHT- GS</i>	<i>AVT- GS</i>	<i>IHT- GS</i>	<i>IVT GS</i>
Checks				
CSH 16	17.0	-	18.0	-
CSH 23	21.0	-	21.0	-
CSH 25	21.0	-	21.0	-
CSH 30	21.0	-	19.0	-
CSV 17	-	16.0	-	12.5
CSV 20	-	25.5	-	11.3
CSV 23	-	14.3	-	18.2
CSV 27	-	13.8	-	11.4
Local check	8.0	25.5	-	12.9
Mean	19.0	12.6	22.6	16.6
Minimum	8.0	9.4	10.0	8.5
Maximum	40.0	32.8	33.0	27.3
Three top ranked entries	SPH 1731, SPH 1705(2), SPH 1703(2) [8.0 to 15.0]	SPV2182, SPV2181, SPV2178 [9.4 to 10.2]	SPH 1748, CSH 16, CSH 30 [10.0 to 19.0]	SPV 2246, CSV 20, CSV 27 [8.5 to 11.4]
Locations considered for National average	Surat	Surat	Surat	Surat
Comments	No report of ergot from other locations			

#### 3.1 Advanced Hybrid Trial (AHT-GS)

AVT-GS trial was comprised of total 18 entries. They included 9 test entries, four hybrid checks, one local check from respective centre and five pathology checks for comparing disease reactions. Ergot was recorded from Surat where location mean was 19.0%. Ergot reactions significantly differed among entries (Table 1.3). Local check GJ38 registered lowest (8.0) and 296B the highest incidence (40%). SPH1731 was resistant and SPH1702 (2), SPH1703 (2), SPH1705 (2) were moderately resistant for ergot.

#### 3.2 Advanced Varietal Trial (AVT-GS)

Number of total entries in AVT-GS was 25. They included 16 test entries, four varietal checks, one local check from respective centre and four pathology checks for comparing disease reactions (Table 2.3). There were significant differences in ergot incidence among the entries. SPV 2182 and SPV 2183 showed resistant reactions (<10%) and others were moderately resistant. Top five entries were SPV 2175, SPV 2179, SPV 2181, SPV 2182 and SPV 2183 [9.4 to 10.5%].

#### 3.3 Initial Hybrid Trial (IHT-GS)

Number of total entries in IHT-GS was 13. They included four test entries, four hybrid checks, one local check from respective centre and four pathology checks for comparing disease reactions (Table 3.3). Entries significantly differed in ergot resistance. SPH 1748 was resistant to ergot and others were moderately resistant. To three entries were SPH 1748, CSH 16 and CSH 30 [10.0 to 19.0%].

#### 3.4 Initial Varietal Trial (IVT-GS)

IVT-GS has total 24 entries. They included 15 test entries, four varietal checks, one local check from respective centre and four pathology checks for comparing disease reactions (Table 4.3). Entries significantly differed in ergot resistance. SPV 2246 was resistant and others were moderately resistant to ergot, where location mean was in moderate reaction zone (16.6%). Top five entries were SPV 2246, CSV 20, CSV 27, SPV 2256 and CSV 17 [8.5 to 12.5%].

#### *Sweet sorghum*

Twenty-four sweet sorghum genotypes including 3 checks and four pathological checks were evaluated against ergot under natural conditions. The disease was reported from Surat in low to moderate form. Incidence was recorded in percentage (where, up to 10% resistant; 11-30% moderately resistant; 31-50% susceptible; and >50% highly susceptible).

### All India summary results (Ergot, %)

Trial details	Trial names
	<i>IAVHT-SS</i>
Checks	
CSH 22SS	11.5
CSV 19SS	18.1
CSV 24SS	13.8
Local check	-
Mean	19.1
Minimum	10.4
Maximum	28.5
Five top ranked entries	SPV 2196, CSH22 SS, SPV 2271, SPV 2195, CSV 24 SS [10.4 to 13.8]
Locations considered for National average	Surat
Comments	No report of ergot from locations other than Surat

### 3.5 Initial & Advanced Varietal & Hybrid Trial

Twenty genotypes including 3 checks and one local check were evaluated for ergot resistance. Four pathology checks were used for comparing disease reactions. The disease was recorded at Surat with location mean 19.1. There were no significant differences in ergot resistance among the entries. All the entries showed moderately resistant reactions (<30%). Top five entries were SPV 2196, CSH22 SS, SPV 2271, SPV 2195 and CSV 24 SS [10.4 to 13.8].

### 4. Downy Mildew (*Peronosclerospora sorghi*)

Dharwad and Coimbatore are two hot spot for sorghum downy mildew (SDM). Systemic SDM due to soil borne infection and local lesion due to air-borne infection occur in these locations. Four grain sorghum trials were evaluated for downy mildew resistance under natural conditions. Incidence of downy mildew was recorded in percentage. Standard method of resistance grading i.e. resistance =10 % SDM; MR = 11-30% SDM was followed. During kharif 2013 the disease was reported from Dharwad and Coimbatore. Location severity index (LSI) for Dharwad assessed over all the trials in the location indicated that disease severity was very high (LSI 25.0) (Table S3). The disease was, however, low and sporadic in Coimbatore (LSI 3.4).

Table S3. Downy mildew severity index for Dharwad and Coimbatore (%)

Location	AHT	AVT	IHT	IVT	LSI	Min Score	Max Score	Total Entry
DHARWAD	61.1	75.9	64.7	76.7	71.1	25.0	99.0	80
COIMBATORE	2.8	5.1	2.0	2.7	3.4	1.0	17.0	80

### *Grain sorghum*

Grain sorghum entries in four trials (13 in AHT, 20 in AVT, 8 in IHT and 19 in IVT) were evaluated for downy mildew resistance under natural conditions at Coimbatore (Zone I) and Dharwad (Zone II). SDM resistant QL3 and susceptible DMS652 and H112 were used as check. Incidence of downy mildew was recorded in percentage. Standard method of resistance grading i.e. resistance =10 % SDM; MR = 11-30% SDM was followed. Disease incidence ranged from 1 to 17% in Coimbatore and 25 to 99% in Dharwad indicating resistant to highly susceptible disease reactions.

#### 4.1 Advanced Hybrid Trial (AHT-GS)

AVT-GS trial was comprised of total 18 entries. They included 9 test entries, four hybrid checks, one local check from respective centre and five pathology checks for comparing disease reactions (Table 1.3). Entries differed significantly and maximum downy mildew was recorded on Bulk Y (98%) and minimum on SPH 1702(2) (25%). Except SPH 1702(2) all other entries were susceptible. Entries SPH 1702(2) and SPH 1733 were at par with best check CSH 25. Top five entries were SPH 1702(2), SPH 1733, CSH 25, CSH 16, CSH 30 [25 to 51].

### All India summary results (Downy mildew, %)

Trial details	Trial names			
	<i>AHT- GS</i>	<i>AVT- GS</i>	<i>IHT- GS</i>	<i>IVT GS</i>
Checks				
CSH 16	44	-	37	-
CSH 23	60	-	57	-
CSH25	31	-	25	-
CSH30	51	-	54	-
CSV 17	-	56	-	63
CSV 20	-	87	-	78
CSV 23	-	66	-	87
CSV 27	-	80	-	93
Local check	69	67	-	71
Bulk Y	90	99	98	98
Mean	60	76	65	77
Minimum	25	42	25	45
Maximum	3198	99	99	98
Five top ranked entries	SPH 1702(2), SPH 1733, CSH 25, CSH 16, CSH 30 [25 to 51]	CSV 17, SPV 2110 (2), SPV 2170, SPV 2175, CSV 23 [42 to 66]	CSH 25, CSH 16, SPH 1748, CSH 30, CSH 23 [25 to 57]	SPV 2244, SPV 2248, SPV 2249, SPV 2250 SPV 2253 [45 to 58]
Entries on par with best hybrid/variety check	SPH 1702(2), SPH 1733	SPV 2110 (2), SPV 2170, SPV 2172, SPV 2175	None	SPV 2244, SPV 2248, SPV 2249, SPV 2250, SPV 2253
Locations considered for National average	Dharwad	Dharwad	Dharwad	Dharwad
Comments	Minor incidence at Coimbatore. No other centre reported incidence			

#### 4.2 Advanced Varietal Trial (AVT-GS)

Number of total entries in AVT-GS was 25. They included 16 test entries, four varietal checks, one local check from respective centre and four pathology checks for comparing disease reactions (Table 2.3). Maximum downy mildew was recorded on Bulk Y (99%) and minimum on B58586 (42%). Entries differed significantly but all were in susceptible disease range because of high disease pressure. Entries SPV 2110 (2), SPV 2170, SPV 2172, SPV 2175 were at par with best check CSV 17. Top five entries were CSV 17, SPV 2110 (2), SPV 2170, SPV 2175 and CSV 23 [42 to 66].

#### 4.3 Initial Hybrid Trial (IHT-GS)

Number of total entries in IHT-GS was 13. They included four test entries, four hybrid checks, one local check from respective centre and four pathology checks for comparing disease reactions (Table 3.3). Maximum downy mildew was recorded on 296B (99%) and minimum on CSH 25 (25%). Entries differed significantly but all were in susceptible disease range. None of the entries was at par with best performing check CSH 25. Top five entries were CSH 25, CSH 16, SPH 1748, CSH 30, CSH 23 [25 to 57].

#### 4.4 Initial Varietal Trial (IVT-GS)

IVT-GS has total 24 entries. They included 15 test entries, four varietal checks, one local check from respective centre and four pathology checks for comparing disease reactions (Table 4.3). Entries differed significantly but all were in susceptible disease range because of high disease pressure. Entries SPV 2244, SPV 2248, SPV 2249, SPV 2250, SPV 2253 were at par with the best performing check CSV 17. Top five entries were SPV 2244, SPV 2248, SPV 2249, SPV 2250 SPV 2253 [45 to 58].

#### *Forage sorghum*

Forage sorghum trials were not allotted to Dharwad for testing downy mildew resistance.

#### *Sweet sorghum*

Sweet sorghum trials were not allotted to Dharwad for testing downy mildew resistance.

### 5. Foliar Diseases

Economic significance of foliar disease varies with location, prevailing environmental conditions, cropping season and type of sorghum grown (grain, forage and sweet sorghum). Foliar diseases destroy active leaf area required for photosynthesis, adversely affect accumulation of sugar in stalk and thus interfere with the quantity and quality

of fodder. Most of the foliar diseases of grain sorghum also occur in forage and sweet sorghum. Anthracnose, leaf blight, rust, zonate leaf spot and few other leaf diseases occurs almost regularly either in moderate or severe form in various parts of India.

Location severity index (LSI) for different diseases indicated that anthracnose severity was moderate at Pantnagar and Surat and low at Udaipur and Coimbatore (Table S4). Zonate leaf spot was moderate to severe at Udaipur, Pantnagar and Coimbatore and low at Dharwad and Surat. Leaf blight was moderate at Pantnagar, Udaipur, and Coimbatore and low Dharwad and Surat. Leaf blight incidence was moderate at Surat and low at Udaipur, Coimbatore and Parbhani. Rust incidences during this season were sporadic and low and recorded only in Parbhani, Dharwad and Coimbatore. Moderate incidence of sooty stripe was recorded only in Akola. Other foliar diseases like rough and gray leaf spot were highly sporadic in incidence and occurred in Parbhani and Akola location.

**Table S4. Foliar disease severity index for different locations**

Foliar disease	AHT	AVT	IHT	IVT	IAVHT-SS	AVT-SC	IAHT-MC	IVHT-SC	LSI	Max Score	Total Entry
<b>ANTHRACNOSE</b>											
UDA	2.5	2.5	2.6	2.5	3.2	2.8	3.1	2.4	2.7	7.3	156
PAN	5.5	5.5	5.0	5.4	5.3	4.3	4.5	5.5	5.2	6.7	156
COI	1.5		1.9	1.6		2.1	2.3	2.2	1.9	5.0	107
DHA											
PAR											
SUR	3.5	3.5	4.4	4.0	4.5	4.2	4.2	3.8	4.0	6.0	156
<b>ZONATE Leaf spot</b>											
UDA	1.3					4.5	4.6	3.2	3.4	7.3	70
PAN	3.8	4.7	4.2	4.5	4.4	3.6	3.7	4.4	4.2	5.3	156
COI	4.1								4.1	5.0	18
DHA	3.1	3.6	3.6	3.2					3.4	4.5	80
PAR											
SUR						3.3	3.3	2.7	3.1	3.7	52
<b>Leaf BLIGHT</b>											
UDA	2.1	2.8	2.7	2.4	3.5	2.1	2.2	1.6	2.5	6.3	156
PAN											
COI	2.2		2.4	1.8		2.3	2.2	3.1	2.3	4.7	107
DHA											
PAR	2.1	2.0		2.0	1.8				2.0	5.0	91
SUR	3.2	3.8	3.6	4.2	4.2	4.0	3.8	3.6	3.8	5.0	156
<b>RUST</b>											
UDA											
PAN											
COI								1.7	1.7	3.0	19
DHA	2.4								2.4	3.0	18
PAR					2.5		1.9	1.7	2.1	4.0	63
SUR											

### Grain sorghum

Grain sorghum entries in four trials (13 in AHT, 20 in AVT, 8 in IHT and 19 in IVT) were evaluated for foliar disease resistance under artificial/natural conditions in hot spots (Udaipur, Pantnagar and Surat) and other locations. The diseases were scored on 1-9 rating scale in Zone I (Udaipur, Pantnagar Palem & Coimbatore) and Zone II (Akola, Parbhani, Surat & Dharwad).

**All India summary results-AHT (Foliar diseases, 1-9 scale)**

Trial details	Foliar diseases		
	Anthraco	Zonate Leaf spot	Leaf blight
Checks			
CSH 16	4.2	3.5	2.4
CSH 23	4.3	4.0	2.4
CHS25	4.0	4.0	2.4
CSH30	4.5	3.5	2.1



Trial details	Foliar diseases		
	<i>Anthraco</i>	<i>Zonate Leaf spot</i>	<i>Leaf blight</i>
<i>AHT</i>			
Local check	5.2	4.5	2.7
B58586 (R)	3.7	3.5	1.8
296B (MR)	4.0	4.0	2.4
Bulk Y (S)	5.2	4.0	2.1
R'local (S)	5.3	4.0	2.4
Mean	4.4	4.0	2.4
Minimum	3.8	3.5	1.8
Maximum	5.3	4.0	2.7
Five top ranked entries	SPH 1705(2), CSH 25, SPH 1737, CSH 16. SPH1730 [3.8-4.2]	CSH 30, CSH 16, SPH 1724 [3.5-3.5]	SPH 1703(2), SPH 1733, CSH 30, SPH 1702(2), CSH 25 [1.8-2.4]
Entries on par with best hybrid check	all	all	NS
Locations considered for National average	Pantnagar, Surat	Pantnagar, Dharwad,	Udaipur, Parbhani Coimbatore, Surat
Comments	Anthraco pressure was low in other locations	ZLS pressure was low at other locations	LB pressure was low to moderate at all above locations

### 5.1 Advanced Hybrid Trial (AHT-GS)

The trial comprised of 18 entries that include 9 test hybrids, 4 hybrid checks, one local check and two each resistant & susceptible check for foliar diseases (Table 1.4 & 1.5).

**Anthraco:** Anthraco was recorded in Pantnagar, Udaipur, Coimbatore (Zone I) and Surat (Zone II) (Table 1.4). Zone I: In zone I disease pressure was high at Pantnagar and low at Udaipur and Coimbatore. All entries showed moderately resistant reactions (except SPH 1731 and SPH 1733, susceptible). Zone II: At Surat all the entries behaved at par and showed moderately resistant reaction [range, 3.3 to 4.3]. National: Based on all India average all the entries behaved moderately resistant to anthraco. Five top ranked entries were SPH 1705(2), CSH 25, SPH 1737, CSH 16 and SPH1730 [3.8 to 4.2].

**Zonate leaf spot:** The disease was recorded in Pantnagar (Zone I) and Dharwad (Zone II) (Table 1.4). In both the location disease pressure was moderate and entries did not differ significantly on resistance. National: Based on all India average, all the entries behaved as moderately resistant to ZLS. Three top ranked entries were CSH 30, CSH 16 and SPH 1724 [3.5-3.5].

**Leaf blight:** Leaf blight was recorded at Coimbatore, Udaipur (Zone I), Parbhani and Surat (Zone II) (Table 1.5). Zone I: In zone I disease pressure was not sufficient to evaluate for resistance [range 1.5 to 3.1]. Zone II: In zone II pressure was moderate but entries did not differ significantly [range, 1.8 to 2.7]. National: On national basis SPH 1703(2), SPH 1733, CSH 30, SPH 1702(2) and CSH 25 [range, 1.8-2.4] were top ranked five entries and all were resistant.

**Other leaf diseases:** Minor incidence of rough leaf spot in Parbhani, grey leaf spot in Parbhani and Akola, and rust in Dharwad and Udaipur were recorded on few entries (Table 1.3 to 1.5).

### 5.2 Advanced Varietal Trial (AVT-GS)

The trial comprised of 5 entries that include 16 test varieties, 4 varietal checks, one local check and four other checks including resistant & susceptible check for foliar diseases (Table 2.4 & 2.5).

**Anthraco:** Anthraco was recorded in Pantnagar, Udaipur (Zone I) and Surat (Zone II) (Table 2.4). Zone I: At Pantnagar disease pressure was high and most of the entries were susceptible except three entries (SPV 2184, CSV 23 and CSV 27, moderately resistant). Based on zone I average SPV 2184 and CSV 23 were resistant and others were moderately resistant. Zone II: At Surat the entries were significantly different [range 3.0 to 4.0]. Entries SPV 2122(2), SPV 2178 and CSV 23 were resistant and others were moderately resistant. National: Based on all India average entries behaved as resistant to moderately resistant. Two entries SPV 2184 and CSV 23 were resistant. Five top ranked entries were CSV 23, CSV 27, SPV 2184, SPV 2122(2) and SPV 2183 [2.8-3.4].

**All India summary results-AVT (Foliar diseases, 1-9 scale)**

Trial details	Foliar diseases			
	<i>AVT</i>	<i>Anthraco</i>	<i>Zonate Leaf spot</i>	<i>Leaf blight</i>
Checks				
CSV17	3.7	4.5	2.6	
CSV 20	3.7	4.3	2.8	
CSV 23	2.8	3.7	2.8	
CSV27	3.3	3.7	3.3	
Local check	5.4	4.0	3.4	
B58586 (R)	3.4	4.2	2.2	
296B (MR)	3.9	5.0	2.9	
Bulk Y (S)	5.4	5.3	2.9	
R'local (S)	5.3	4.7	3.6	
Mean	3.8	4.2	2.9	
Minimum	2.8	3.7	2.2	
Maximum	5.4	5.3	3.6	
Five top ranked entries	CSV 23, CSV 27, SPV 2184, SPV 2122(2), SPV 2183 [2.8-3.4]	CSV 23, CSV 27, SPV 2178, SPV 1822(2), SPV 2165 [3.7-4.0]	SPV 2122(2), SPV 2183, SPV 2172, CSV 17, SPV 1822(2), SPV 2175 [2.4-2.7]	
Entries on par with best varietal check	All except SPV 21 14 (2)	all	all	
Locations considered for National average	Pantnagar, Udaipur, Surat	Pantnagar, Dharwad	Udaipur, Parbhani, Surat	
Comments	Anthraco pressure was low in other locations	ZLS pressure was low at other locations	LB pressure was moderate at Surat and low at Udaipur and Parbhani	

**Zonate leaf spot:** The disease was recorded in Pantnagar (Zone I) and Dharwad (Zone II) (Table 2.4). In both the location disease pressure was moderate and entries differ significantly on resistance. **National:** Based on all India average, all the entries behaved as moderately resistant to ZLS. Five top ranked entries were CSV 23, CSV 27, SPV 2178, SPV 1822(2) and SPV 2165 [3.7-4.0].

**Leaf blight:** Leaf blight was recorded Udaipur (Zone I), Parbhani and Surat (Zone II) (Table 2.4). **Zone I:** In zone I disease pressure was moderate and entries differ significantly. Most of the entries were resistant (except SPV 2165 and SPV 2184, moderately resistant). **Zone II:** In zone II pressure was moderate but entries did not differ significantly [range, 2.3 to 3.5]. **National:** On national basis SPV 2122(2), SPV 2183, SPV 2172, CSV 17, SPV 1822(2) and SPV 2175 [2.4 to 2.7] were top ranked five entries and all were resistant/ moderately resistant.

**Other leaf diseases:** Minor incidence of sooty stripe in Akola, rough leaf spot in Parbhani, grey leaf spot in Parbhani and Akola, and rust in Dharwad and Udaipur were recorded (Table 2.3 to 2.4).

**5.3 Initial Hybrid Trial (IHT-GS)**

The trial comprised of 13 entries that include 4 test hybrid, 4 hybrid checks, one local check and four other checks including resistant & susceptible check for foliar diseases (Table 3.4).

**Anthraco:** Anthraco was recorded in Pantnagar, Udaipur, Coimbatore (Zone I) and Surat (Zone II) (Table 2.4). **Zone I:** At Pantnagar disease pressure was high and most of the entries were moderately resistant (except SPH 1749 and CSH 30, susceptible). Based on zone I average of two locations SPH 1748, SPH 1750, SPH 1751 and CSH 25 were resistant and others were moderately resistant. **Zone II:** At Surat the entries were statistically and significantly different [range 3.0 to 4.0] but all were in moderately resistant type. **National:** Based on all India average entries behaved as moderately resistant to anthraco. Five top ranked entries were CSH 25, SPH 1751, SPH 1748, SPH 1749 and CSH 23 [3.1 to 3.8].

**All India summary results-IHT (Foliar diseases, 1-9 scale)**

Trial details	Foliar diseases			
	<i>IHT</i>	<i>Anthraco</i>	<i>Zonate Leaf spot</i>	<i>Leaf blight</i>
Checks				
CSH 16	4.0	3.5	3.0	
CSH 23	3.8	3.7	3.0	

Trial details	Foliar diseases		
	<i>IHT</i>	<i>Anthraco</i>	<i>Zonate Leaf spot</i>
CHS25	3.1	3.7	2.1
CSH30	4.2	4.3	3.4
Local check	-	-	-
B58586 (R)	3.2	3.7	2.9
296B (MR)	4.0	4.7	3.7
Bulk Y (S)	5.3	4.7	3.0
R'local (S)	6.4	4.4	3.3
Mean	4.0	3.9	2.9
Minimum	3.1	3.5	2.1
Maximum	6.4	4.7	3.3
Five top ranked entries	CSH 25, SPH 1751, SPH 1748, SPH 1749, CSH 23 [3.1 to 3.8]	CSH 16, CSH 23, CSH 25, SPH 1750, SPH 1748 [3.5 to 3.7]	CSH 25, SPH 1750, SPH 1749, SPH 1748, SPH 1751 [2.1 to 2.9]
Entries on par with best hybrid check	all	all	all
Locations considered for National average	Pantnagar, Udaipur, Coimbatore, Surat	Pantnagar, , Dharwad	Surat, Udaipur, Coimbatore,
Comments	Anthraco pressure was high at Surat and Pantnagar and moderate to low in other locations	ZLS pressure was moderate at Pantnagar & Dharwad and low at other locations	LB pressure was moderate at Surat and low at Coimbatore and Udaipur

**Zonate leaf spot:** The disease was recorded in Pantnagar (Zone I) and Dharwad (Zone II) (Table 3.4). In both the location disease pressure was moderate and entries differ significantly on resistance. **National:** Based on all India average, all the entries behaved as moderately resistant to ZLS. Five top ranked entries were CSH 16, CSH 23, CSH 25, SPH 1750 and SPH 1748 [3.5 to 3.7].

**Leaf blight:** Leaf blight was recorded Udaipur, Coimbatore (Zone I) and Surat (Zone II) (Table 3.4). **Zone I:** In zone I disease pressure was low to moderate. Though entries differ statistically, all was resistant (except CSH 30, moderately resistant). **Zone II:** In zone II pressure was moderate and entries differ significantly [range, 3.3 to 4.0]. **National:** On national basis CSH 25, SPH 1750, SPH 1749, SPH 1748 and SPH 1751 [2.1 to 2.9] were top ranked five entries and all were resistant/ moderately resistant.

**Other leaf diseases:** Minor incidence of sooty stripe in Akola, rough leaf spot in Parbhani, grey leaf spot in Parbhani and Akola, and rust in Dharwad and Udaipur were recorded (Table 3.3 to 3.4).

#### 5.4 Initial Varietal Trial (IVT-GS)

The trial comprised of 24 entries that include 15 test variety, 4 varietal checks, one local check and four other checks including resistant & susceptible check for foliar diseases (Table 4.4 & 4.5).

**Anthraco:** Anthraco was recorded in Pantnagar, Udaipur, Coimbatore (Zone I) and Surat (Zone II) (Table 4.4). **Zone I:** At Pantnagar disease pressure was high and most of the entries were susceptible (except SPV 2248, SPV 225, SPV 2253 and CSH 23, moderately resistant). Disease pressure in Coimbatore and Udaipur was low and not considered for national average. **Zone II:** At Surat the entries showed statistically different because of resistant check [range 3.0 to 5.7] but all test entries were in moderately resistant type. **National:** Based on all India average entries behaved as moderately resistant to anthraco (except SPV 2254, susceptible). Five top ranked entries were SPV 2248, SPV 2252, CSV 23, SPV 2244 and SPV 2247 [4.0 to 4.3].

**Zonate leaf spot:** The disease was recorded in Pantnagar (Zone I) and Dharwad (Zone II) (Table 4.4). In both the location disease pressure was moderate and entries differ statically on resistance. **National:** Based on all India average, all the entries behaved as moderately resistant to ZLS. Five top ranked entries were SPV 2247, SPV 2248, SPV 2244, CSV 23 and SPV 2249 [3.3 to 3.8].

**All India summary results-IVT (Foliar diseases, 1-9 scale)**

Trial details	Foliar diseases		
	Anthracnose	Zonate Leaf spot	Leaf blight
IVT			
Checks			
CSV17	5.0	3.8	2.4
CSV 20	5.0	3.8	2.1
CSV 23	4.3	3.7	2.1
CSV27	4.3	4.0	3.1
Local check	5.2	3.8	2.7
B58586 (R)	3.7	3.5	1.5
296B (MR)	4.7	4.3	2.4
Bulk Y (S)	5.7	4.7	1.5
R'local (S)	6.2	5.0	2.1
Mean	4.7	3.8	2.4
Minimum	3.7	3.3	1.8
Maximum	6.2	5.0	3.1
Five top ranked entries	SPV 2248, SPV 2252, CSV 23, SPV 2244, SPV 2247 [4.0 to 4.3]	SPV 2247, SPV 2248, SPV 2244, CSV 23, SPV 2249 [3.3 to 3.8]	SPV 2248, SPV 2243, CSV 23, CSV 20, CSV 17 [2.1 to 2.4]
Entries on par with best varietal check	all	all	All except SPV 2252
Locations considered for National average	Pantnagar, Surat	Pantnagar, Dharwad	Udaipur, Parbhani, Surat
Comments	Anthracnose pressure was high at Pantnagar & Surat, moderate at Udaipur and low at Coimbatore	ZLS pressure was moderate at Pantnagar & Dharwad	LB pressure was moderate at Surat, and low at other locations

**Leaf blight:** Leaf blight was recorded Udaipur, Coimbatore (Zone I), Parbhani and Surat (Zone II) (Table 4.4). **Zone I:** In zone I disease pressure was low and entries did not differ statistically. **Zone II:** In zone II pressure was moderate and entries differ significantly [range, 2.1 to 3.5]. **National:** On national basis SPV 2248, SPV 2243, CSV 23, CSV 20 and CSV 17 [2.1 to 2.4] were top ranked five entries (all were resistant/ moderately resistant).

**Other leaf diseases:** Minor incidence of sooty stripe in Akola, rough leaf spot in Parbhani, grey leaf spot in Parbhani and Akola, and rust in Dharwad and Udaipur were recorded (Table 4.3 & 4.5).

**5.5 Initial Varietal & Hybrid Trial (Single cut)**

The trial comprised of 19 entries that include 12 test varieties, 3 checks, one local check and three other checks including resistant & susceptible check for foliar diseases (Table 5.2 & 5.3).

**All India summary results-IVHT-Single cut (Foliar diseases, 1-9 scale)**

Trial details	Foliar diseases		
	Anthracnose	Zonate Leaf spot	Leaf blight
IVHT-SC			
Checks			
CSH 27	3.3	2.7	3.3
CSV 21F	3.5	2.8	3.3
HC 308	3.0	2.5	3.7
Local check	4.6	4.0	2.8
Bulk Y (S)	4.4	3.8	3.0
Pant Chari 5 (R)	4.7	3.9	2.2
R'local (S)	4.1	2.3	3.3
Mean	3.5	3.0	3.3
Minimum	2.6	2.3	2.2
Maximum	4.7	4.0	3.8
Five top ranked entries	SPV 2261, SPV 2262, SPV 2263, SPV 2257, SPV 2259 [2.6 to 3.1]	SPV 2261, SPV 2259, HC 305, SPV 2264, SPV 2265 [2.3 to 2.6]	SPV 2259, SPV 2261, SPV 2266, SPV 2262, SPV 2264 [3.0 to 3.2]
Entries on par with best hybrid/varietal check	all	all	all
Locations considered for National average	Pantnagar, Udaipur, Coimbatore, Surat	Pantnagar, Udaipur, Surat	Surat, Coimbatore
Comments	Pressure was high at Pantnagar, moderate at Surat and low at Coimbatore	ZLS pressure was moderate at Pantnagar, Udaipur, Surat and low at Akola	LB pressure was moderate at all above locations except Udaipur

**Anthracnose:** Anthracnose was recorded in Pantnagar, Udaipur, Surat (Zone I) and Coimbatore (Zone II) (Table 5.2). Zone I: At Pantnagar and Surat disease pressure was high and susceptible check recorded up to 6.7. In Udaipur local check had 6.3 score but other entries did not get much disease causing low location mean (2.4). In zone I, SPV 2262 was resistant and others were moderately resistant. Zone II: At Coimbatore only susceptible checks got disease and entries were almost free from anthracnose. National: Based on all India average entries behaved as resistant to moderately resistant to anthracnose. Five top ranked entries were SPV 2261, SPV 2262, SPV 2263, SPV 2257 and SPV 2259 [2.6 to 3.1].

**Zonate leaf spot:** The disease was recorded in Pantnagar, Udaipur, Surat (Zone I) and Akola (Zone II) (Table 5.2). In zone I, SPV 2259 and SPV 2261 were resistant. In zone II all entries showed resistance except SPH 1753. National: Based on all India average, all the entries behaved as resistant to moderately resistant to ZLS. Five top ranked entries were SPV 2261, SPV 2259, HC 305, SPV 2264 and SPV 2265 [2.3 to 2.6].

**Leaf blight:** Leaf blight was recorded Udaipur, Surat (Zone I), and Coimbatore (Zone II) (Table 5.3). Zone I: In zone I disease pressure was low to moderate but entries differ statistically. SPV 264 was resistant and others were moderately resistant. Zone II: In zone II pressure was moderate and entries differ significantly [range, 3.0 to 4.3]. National: On national basis SPV 2259, SPV 2261, SPV 2266, SPV 2262, SPV 2264 [3.0 to 3.2] were top ranked five entries and all were resistant/ moderately resistant.

**Other leaf diseases:** Minor incidence of sooty stripe in Akola, rough leaf spot in Parbhani, grey leaf spot in Parbhani and Akola, and rust in Udaipur were recorded (Table 5.1 to 5.3).

#### 5.6 Advanced Varietal Trial (Single cut)

The trial comprised of 13 entries that include 6 test varieties, 3 checks, one local check and three other checks including resistant & susceptible check for foliar diseases (Table 6.2).

**All India summary results-AVT- Single cut (Foliar diseases, 1-9 scale)**

Trial details	Foliar diseases		
	Anthracnose	Zonate Leaf spot	Leaf blight
AVT-SC			
Checks			
CSV 21F	3.8	3.0	2.1
CSV 21F(1)	3.2	3.1	2.7
HC 308	3.9	4.0	2.7
Local check	4.4	3.8	2.7
Bulk Y (S)	3.4	3.1	2.7
Pant Chari 5 (R)	3.3	2.4	2.1
R'local (S)	3.3	2.6	2.4
Mean	3.8	3.3	2.7
Minimum	3.2	2.6	2.1
Maximum	4.4	4.4	3.5
Five top ranked entries	SPV 2211, CSV 21F(1) CSV 21F(1), SPV 2128(2) [3.2 to 3.6]	SPV 2128(2), CSV 21F, SPV 2190 [2.9 to 3.1]	CSV 21F, SPV 2191, SPV 2185, HC 308 [2.1 to 2.7]
Entries on par with best varietal check	SPV 2128(2), SPV 2190, SPV 2211	all	all
Locations considered for National average	Pantnagar, Udaipur, Surat	Pantnagar, Udaipur, Surat	Udaipur, Coimbatore, Surat
Comments	Anthracnose pressure was moderate at all above locations and low at Coimbatore	ZLS pressure was high at Udaipur and moderate at Pantnagar & Udaipur	LB pressure was moderate at Surat and low all other locations

**Anthracnose:** Anthracnose was recorded in Pantnagar, Udaipur, Surat (Zone I) and Coimbatore (Zone II) (Table 6.2). Zone I: At Pantnagar and Surat disease pressure was moderate to high and location means were 4.3 and 4.2. In Udaipur entries were moderately resistant except SPV 185 and SPV 191 which were susceptible. In zone I all the entries were moderately resistant to anthracnose. Zone II: At Coimbatore disease pressure was low and entries were almost free from anthracnose. National: Based on all India average entries behaved as moderately resistant to anthracnose. Five top ranked entries were SPV 2211, CSV 21F (1) CSV 21F(1) and SPV 2128(2) [3.2 to 3.6].

**Zonate leaf spot:** The disease was recorded in Pantnagar, Udaipur, Surat (Zone I) and Parbhani (Zone II) (Table 6.2). In zone I all entries were moderately resistant. In zone II disease pressure was low and evaluation could not be reliable. **National:** Based on all India average, all the entries behaved as resistant to moderately resistant to ZLS. Three top ranked entries were SPV 2128(2), CSV 21F and SPV 2190 [2.9 to 3.1].

**Leaf blight:** Leaf blight was recorded Udaipur, Surat (Zone I), and Coimbatore (Zone II) (Table 6.1). **Zone I:** In zone I, disease pressure was moderate at Surat and low at Udaipur and entries could not differ significantly. **Zone II:** In zone II, pressure was low and entries did not differ significantly [range, 1.8 to 2.7]. **National:** Based on all India average entries behaved as resistant or moderately resistant to LB. Five top ranked entries were CSV 21F, SPV 2191, SPV 2185 and HC 308 [2.1 to 2.7].

**Other leaf diseases:** Minor incidence of sooty stripe in Akola, rough leaf spot in Parbhani, grey leaf spot in Parbhani and Akola, and rust in Udaipur were recorded (Table 6.1 & 6.2).

### 5.7 Initial & Advanced Varietal & Hybrid Trial (Multi cut)

The trial comprised of 20 entries that include 13 test entries, 2 hybrid and 1 varietal checks, one local check and three other checks including resistant & susceptible check for foliar diseases (Table 7.1 & 7.2).

**All India summary results-IAVHT-Multi-cut (Foliar diseases, 1-9 scale)**

Trial details	Foliar diseases		
	Anthracnose	Zonate Leaf spot	Leaf blight
IAVHT			
Checks			
SSG-59-3	4.4	3.5	3.3
CSH 20MF	3.6	3.2	2.8
CSH 24MF	3.3	2.9	3.0
Local check	5.9	4.1	4.4
Bulk Y (S)	4.1	3.4	2.2
Pant Chari 5 (R)	5.4	3.6	2.6
R'local (S)	3.4	2.4	2.8
Mean	4.0	3.3	3.0
Minimum	3.3	2.4	2.2
Maximum	5.4	4.4	4.4
Five top ranked entries	SPH 1717, SPH 1749, SPH 1753, SPH 2242, CSH 24MF [3.2 to 3.3]	SPH 1753, SPH 2242, CSH 24MF, SPH 1695, SPH 1748 [2.4 to 3.0]	SPH 1753, SPH 2242, SPH 1697, SPH 1752 [2.5 to 2.8]
Entries on par with best hybrid/varietal check	all	NS	all
Locations considered for National average	Pantnagar, Udaipur, Surat	Pantnagar, Udaipur, Coimbatore, Dharwad, Surat	Udaipur, Surat
Comments	Anthracnose pressure was moderate all above locations	ZLS pressure was high at Udaipur, moderate at Pantnagar & Surat and low at Parbhani	LB pressure was moderate at Surat and low at Udaipur and Coimbatore

**Anthracnose:** Anthracnose was recorded in Pantnagar, Udaipur, Surat (Zone I) and Coimbatore (Zone II) (Table 7.1). **Zone I:** At Pantnagar and Surat disease pressure was moderate to high and susceptible check recorded up to 6.0. In Udaipur local check had 7.3 score but other entries did not get much disease causing low location mean (3.1). In zone I all the entries were moderately resistant to anthracnose. **Zone II:** At Coimbatore only susceptible checks got disease and entries were almost free from anthracnose. **National:** Based on all India average entries behaved as moderately resistant to anthracnose. Five top ranked entries were SPH 1717, SPH 1749, SPH 1753, SPH 2242 and CSH 24MF [3.2 to 3.3].

**Zonate leaf spot:** The disease was recorded in Pantnagar, Udaipur, Surat (Zone I) and Parbhani (Zone II) (Table 7.1). In zone I SPH 1753 and SPV 2242 were resistant and others were moderately resistant. In zone II disease pressure was low and evaluation could not be reliable. **National:** Based on all India average, all the entries behaved as resistant to moderately resistant to ZLS. Three top ranked entries were SPH 1753, SPH 2242, CSH 24MF, SPH 1695 and SPH 1748 [2.4 to 3.0].

**Leaf blight:** Leaf blight was recorded Udaipur, Surat (Zone I), and Coimbatore (Zone II) (Table 7.2). Zone I: In zone I disease pressure was moderate at Surat and low at Udaipur and entries differ statistically. Zone II: In zone II pressure was moderate and entries differ significantly [range, 1.0 to 3.0]. National: Based on all India average entries behaved as resistant or moderately resistant to LB. Five top ranked entries were SPH 1753, SPH 2242, SPH 1697, SPH 1752 [2.5 to 2.8].

**Other leaf diseases:** Minor incidence of sooty stripe in Akola, rough leaf spot in Parbhani, grey leaf spot in Parbhani and Akola, and rust in Udaipur were recorded (Table 7.1 & 7.2).

### *Sweet sorghum*

#### 5.8 Initial & Advanced Varietal & Hybrid Trial

Twenty-four sweet sorghum genotypes including 3 checks and four pathological checks were evaluated against foliar diseases at hot spot locations under natural conditions. They were evaluated at Pantnagar, Udaipur Palem (Zone I), Parbhani, Akola and Surat (Zone II) against foliar diseases (Table 8.2).

**All India summary results-IAVHT-Sweet sorghum (Foliar diseases, 1-9 scale)**

Trial details	Foliar diseases		
	Anthracnose	Zonate Leaf spot	Leaf blight
IAVHT-SS			
Checks			
CSH 22SS	4.1	5.0	3.0
CSV 19SS	4.8	4.3	3.1
CSV 24SS	5.2	4.7	3.5
B58586 (R)	3.4	4.0	2.4
296B (MR)	4.3	4.3	2.9
Bulk Y (S)	4.8	4.3	2.7
R'local (S)	5.7	5.0	2.8
Mean	4.3	4.4	3.2
Minimum	2.9	3.3	2.4
Maximum	5.7	5.0	4.1
Five top ranked entries	SPH 1755, SPV 2205, SPV 2241, SPV 2268, SPV 2196 [2.9 to 3.9]	SPV2271, SPH 17555, SPV 2268 [3.3 to 4.0]	SPH 1754, SPH 1755, SPV 2268, SPH 1739, SPV 2241 [2.7 to 2.8]
Entries on par with best hybrid check	NS	NS	NS
Locations considered for National average	Pantnagar, Udaipur, Surat	Pantnagar	Udaipur, Akola, Surat
Comments	Anthracnose pressure was moderate to high at above locations	ZLS pressure was high at Pantnagar & sporadic in other locations	LB pressure was moderate at Surat and Udaipur and low at Parbhani and Akola

**Anthracnose:** Anthracnose was recorded in Pantnagar, Udaipur, (Zone I), and Surat (Zone II) (Table 8.2). Zone I: At Udaipur and Pantnagar disease pressure was moderate to high where the susceptible check recorded 5.8. SPV 1755 was resistant and all the entries were moderately resistant reaction (except SPV 2269 and SPV 2272). Zone II: At Surat SPV 1755 was resistant other entries were moderately resistant [range 3.7 to 5.0]. National: Based on all India average SPV 1755 was resistant. Top five entries were SPV 1755, SPV 2205, SPV 2241, SPV 2268 and SPV 2196 [2.9 to 3.9]

**Zonate leaf spot:** The disease was recorded at Pantnagar in moderate form (Zone I). Incidence was sporadic at Udaipur, (Zone I) and Parbhani and Akola (Zone II) (Table 8.2). Zone I: In this zone all test entries were moderately resistant where the susceptible check R'local recorded (5.5) [range 3.3 to 5.0]. National: To three entries were SPV2271, SPV 17555 and SPV 2268.

**Leaf blight:** Leaf blight was recorded at Udaipur (Zone I), Parbhani, Akola and Surat (Zone II) (Table 8.2). Zone I: At Udaipur location entries showed significantly different scores for leaf blight resistance. Except SPV 2196 and SPV 2271 other entries showed either resistant of moderately resistant reactions. Zone II: Disease pressure was low at Parbhani and Akola. And entries could not be properly evaluated. In Surat all the entries were moderately resistant. National: Five top ranked entries were SPV 1754, SPV 1755, SPV 2268, SPV 1739 and SPV 2241 [2.7 to 2.8].

Other leaf diseases: Minor incidence of rough leaf spot in Parbhani and Akola, and Grey leaf spot in Akola were recorded on few sweet sorghum entries.

## 6. National Grain Mold Nursery

Objective of this study was to monitor stability of grain mold resistance in newly identified and known sources and study pathogen population across locations. Sixteen entries contributed by various centres along with six grain mold resistant and susceptible checks were evaluated at grain mold hot spots like Akola, Dharwad, Hyderabad and Palem. Field experiment was conducted in RBD with 2 replications. Each test entry was sown in two rows of 4 m long and 45 cm apart. Grain mold was scored following 1 to 9 rating scale on grains on panicle and on threshed grains. Other grain mold related characters like days to flowering, plant height, panicle compactness, glume cover, fungal load etc were recorded. Results are presented in Tables 9.1, 9.2 & 9.3. Entries SGMRN 12-3-1, R10-MP 13, GMR 156-1 and GMR 166-1 were resistant for PGS and SGMRN 12-3-1 and GMR 156-1 were resistant for TGS. Entries AKMGR 104, AKMGR 103, GMR 84-2, PSGVS 106, GMR 83-1, SU 1363 and GMR 166-1 recorded less than 20% *Fusarium* and PSGVS 106, GMR 166-1, SGMRN 12-3-1, AKMGR less than 15% *Curvularia* infection. Top ten promising test entries for different grain mold characters are given below;

Promising entries in NGN

PGS <4.0	TGS <4.0	Fusarium	Curvularia	Seed weight	Frequency	Entry promoted
SGMRN 12-3-1	SGMRN 12-3-1	AKMGR 104	PSGVS 106	PSGVS 106	GMR 166-1(5)	GMR 166-1
R 10-MP 13	GMR 156-1	AKMGR 103	GMR 166-1	AKMGR 101	GMR 84-2(5)	GMR 84-2
GMR 166-1	GMR 83-1	GMR 84-2	SGMRN 12-3-1	GMR 156-1	PSGVS 106(5)	PSGVS 106
GMR 156-1	GMR 84-2	GMR 83-1	AKMGR 101	GMR 84-2	SU 1363(4)	SU 1363
PSGVS 106	GMR 124-1	PSGVS 106	R 10-MP 13	AKMGR 104	GMR 124-1(4)	GMR 124-1
GMR 84-2	R 10-MP 13	SU 1363	GMR 124-1	GMR 144-1	GMR 156-1(4)	GMR 156-1
GMR 83-1	PSGVS 106	GMR 166-1	GMR 156-1	SU 1363	GMR 83-1(4)	GMR 83-1
AKMGR 100	GMR 166-1	SGMRN 12-3-1	SU 1363	GMR 83-1	SGMRN 12-3-1(4)	SGMRN 12-3-1
SU 1363		AKMGR 101	GMR 84-2	AKMGR 103	AKMGR 101(3)	AKMGR 101
GMR 124-1		GMR 124-1	AKMGR 104	GMR 166-1	AKMGR 104(3)	AKMGR 104
					R 10-MP 13(3)	R 10-MP 13
					AKMGR 103(2)	
					AKMGR 100(1)	
					GMR 144-1(1)	

For study of pathogen population on immature grain spikelet containing tender grains were sampled at 10 days after 50% anthesis from five genotypes including 4 grain mold checks (B58586, R'local, 296B and Bulk Y) and one local check. From each entry at least 4 to 5 panicles were sampled, pooled and immediately sent to DSR Hyderabad for fungal analysis. Some of the samples were highly damaged because of moisture in immature seed and delay in transit. Such samples showed high infection of stored fungi like *Aspergillus* and *Penicillium*. *Fusarium* infection was lowest in Surat and *Curvularia* in Pantnagar. *Alternaria* and *Bipolaris* infection was sporadic in all locations [range, 0 to 1.7%]. About 50 to 90% seed was infected at tender age at various locations. High percentage was because of contamination during transit. Among genotypes *Fusarium* infection was lowest in B58586 and *Curvularia* in 296B.

Fungal infection on immature sorghum seed (%) at different locations and genotypes

Location	<i>Fusarium</i>	<i>Curvularia</i>	<i>Alternaria</i>	<i>Bipolaris</i>	<i>Aspergillus</i>	<i>Penicillium</i>	Total
Coimbatore	52a	22a	1.7a	0a	0b	0.6b	76ab
Dharwad	46a	15a	1.7a	0.2a	0b	0.6b	64b
Palem	38ab	16a	0.3ab	0.4a	3.9b	1.1b	59b
Pantnagar	54a	1b	0.1b	0a	0b	2.1b	56b
Surat	24b	17a	0.4ab	0.2a	28.4a	15.8a	90a
<b>Genotype</b>							
296B	75a	5c	0.4a	0a	0.9a	2.8ab	84a
B58586	19c	26a	1.6a	0.3a	7.3a	1.7b	55bc
Bulk-Y	47b	12bc	0.5a	0.1a	7.5a	10.7a	78ab
R'local	36bc	23ab	1.5a	0.1a	8.8a	1.5b	71ab
LC	27bc	5c	0.3a	0.4a	10.4a	0.5b	48c



## 7. Pest and Disease Resistant Nursery

Objective of this study was to identify combined resistance for grain mold and shoot fly in newly identified and known sources of resistance. Four locations (Dharwad, Akola, Udaipur and Palem) for evaluation for diseases resistance and four (Parbhani, Akola, Dharwad, Hyderabad) for pest resistance were chosen. Experiments were conducted using 15 entries that included 7 test entries and 8 checks for pests and disease resistance. The test entries were scored for grain mold and other diseases by pathologist and for shoot fly by entomologist using standard procedures. Pathological results are presented in Table 10.1 & 10.2. Out of seven entries four were resistant/ moderately resistant to grain mold (GMR308, GMR156, GMR144-2, GMR309, score<5.0) and others were susceptible. All were resistant to anthracnose but susceptible to downy mildew.

## 8. Field Monitoring of Virulence for Anthracnose

Objective of this study was to characterize the virulence spectrum of the anthracnose pathogen in hot spots. Pathogenic variability in isolates of *Colletotrichum graminicola* was studied on the basis of differential reactions on foliage of sorghum cultivars. Pathogenicity of 10 isolates from different localities in Uttarakhand was tested on leaves of 10 cultivars. Five differential lines (IRAT 204, IS 18442, IS 8354Kekri local and IS 3089) were obtained from Udaipur and three (CSV 21F, PC 1002 and R Local) were used from Pantnagar. Plants were inoculated with pathogen infested sorghum grains (2-3 grains) by placing them into the whorl of 20 days old plants. Disease severity was recorded in 1 to 9 scale at boot leaf emergence and soft dough stage. Average disease reactions of the two observations are given in Table S5. Results revealed that CgD and CgL was highly virulent isolate that could register 8 susceptible reactions out of 10 lines (Table S5). CgB and CgS, on the other hand, was least virulent of the ten isolates that could register 6 susceptible reactions. Because of high disease pressure pathogenic variability was narrowed down. None of the isolates could produce susceptible disease reactions on pant Chari-5 suggesting the line might have adequate resistant to anthracnose. In terms of aggressiveness CgA was the most and CgS was the least aggressive isolate on this set of sorghum lines (Fig. 2).

Table S5. Anthracnose reactions of different isolates on sorghum lines

Isolate	Kekri local	IS 8354	IS 18442	IRAT 204	IS 2312	IS3089	CSV 21F	R local	SSG 59-3	Pant Chari-5
CgA	HS	HS	HS	S	S	S	MR	HS	MR	R
CgB	HS	S	S	MR	S	S	MR	S	MR	R
CgC	S	HS	S	MR	S	S	S	S	MR	R
CgD	S	S	S	MR	S	S	S	HS	S	R
CgF	S	S	S	S	S	HS	MR	HS	MR	R
CgH	HS	S	S	MR	S	S	S	S	MR	R
CgK	HS	S	S	MR	MR	S	S	S	S	R
CgL	HS	HS	S	MR	S	S	S	HS	S	R
CgN	HS	S	S	MR	S	S	S	HS	MR	R
CgS	S	S	S	MR	S	S	MR	S	MR	R

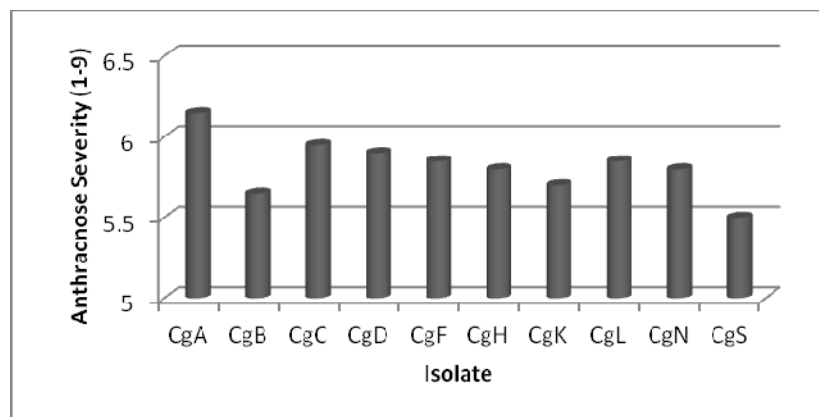


Fig. 2. Aggressiveness of *Colletotrichum graminicola* isolates on sorghum lines

## 9. Publications and Recognitions

The group was involved in publishing thirteen research articles during 2013 in national (10) and international journals (3). Sixteen abstracts were presented in different symposia. Akola centre received the best poster award in international symposium. List of journal articles is given below.

1. Basha S. Ameer, G.Raghavendra, M.V. Nagesh Kumar, K. Dharma Reddy and R. Sudhakar. 2013. Performance of native fluorescent *Pseudomonas* on *in vitro* seed germination and seedling vigour of *sorghum bicolor*. International Journal of Bioresource and Stress Management. Vol 4(4): 487 – 491.
2. Basha S. Ameer, A.S Begum, G. Raghavendra, D. Subba Rao. 2013. Sensitivity of *Pseudomonas fluorescens* and *Rhizobium* to various antibiotics under *in vitro*. (International Journal of Bioresource and Stress Management. (Accepted).
3. Begum AS, S. Ameer Basha, Govardhanam Raghavendra, Mallele Venkata Nagesh Kumar, Yukthi Singh, Jagannath V Patil, Yuhei Tanemura and Yoshinori Fujimoto. 2014. Isolation and characterization of antimicrobial cyclic dipeptides from *Pseudomonas fluorescens* and their efficacy on sorghum grain mold fungi. Chemistry and Biodiversity Vol (11): 92 – 100.
4. Bhanderi G.R., K.A. Patel and B.G. Solanki. 2013. Juvar na Rogo. Krushi Go Vidya (Accepted)
5. Das IK, Annapurna, A and Patil JV. 2013. Effect of panicle characters and plant height on premature seed not caused by fusarium grain mold in sorghum. Indian Journal of Plant Protection, 41(3): 238-243.
6. Das, IK. 2013. Management and Utilization of Microbial Resource Associated with Plants. Pages 199-201, In: Elangovan, M and Patil, JV (Eds.). Managing Intellectual property under PVP and PGR. Directorate of Sorghum Research, Hyderabad, 280pp, ISBN: 81-89335-44-8.
7. Gadewar AG, Narayana, Y.D, Prabhakar and Samadur, M.Y. 2013. Charcoal rot due to *Macrophomina phaseolina* and its relation with pith disintegration and nodal colonization in *Sorghum bicolor*. Indian Phytopathology, 66(2): 140-143.
8. Kharayat, B.S. and Y. Singh. 2013. Evaluation of inoculation techniques for screening sorghum genotypes against stalk rot caused by *Erwinia chrysanthemi*. Indian Phytopath.66 (4): 400-402.
9. Kharayat, B. S. and Y. Singh. 2013. Unusual occurrences of *Erwinia* stalk rot of sorghum in tarai region of Uttarakhand. Internat. J. Agric. Sci. 9 (2): 809-813.
10. Purohit, J., Y. Singh, S. Bisht and A. Srinivasraghvan. 2013. Evaluation of antagonistic potential of *Trichoderma harzianum* and *Pseudomonas fluorescens* isolates against *Gloeocercospora sorghi* causing zonate leaf spot of sorghum. The Bioscan, 8 (4):1327-1330.
11. Purohit, J., Y. Singh, P.B. Holeyachi and N. Gupta. 2014. Field evaluation of sorghum genotypes to zonate leaf spot disease. Environment and Ecology. 32 (1): 174-177.
12. Rajkumar, B. Fakrudin, S. P. Kavil, Y. Girma, S. S. Arun, D. Dadakhalandar, B. H. Gurusiddesh, A. M. Patil, M. Thudi, S. B. Bhairappanavar, Y. D. Narayana, P. U. Krishnaraj, B. M. Khadi & M. Y. Kamatar. 2013. Molecular mapping of genomic regions harbouring QTLs for root and yield traits in sorghum (*Sorghum bicolor*). Physiol. Mol. Bio. Plants, 19(3):409-419.
13. Yadav R L, R N Bunker and S S Sharma. 2013. Variations in cultural characters and pathogenic virulence among the isolates of *Bipolaris maydis* causing maydis leaf blight of maize (*Zea mays L.*), J Mycol Plant Pathol, Vol. 43, (3) pp.1-4.

### Annexure I: Performance of the Centres

Trial No.	1	2	3	4	5	6	7	8	9	10	11	
Sr.	Trail/ Location	AHT- GS	AVT- GS	IHT- GS	IVT- GS	IVHT- SC	AVT- SC	IAVHT- MC	IAVHT- SS	NGN	PDRN	FVM
1	Parbhani	Y	Y	Y	Y	Y	Y	Y	Y	-	-	-
2	Akola	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-
3	Dharwad	Y	Y	Y	Y	-	-	-	-	Y	Y	-
4	Coimbatore	Y	Y	Y	Y	Y	Y	Y	-	-	-	-
5	Palem	Y	Y	Y	Y	-	-	-	Y	Y	-	-
6	Surat	Y	Y	Y	Y	Y	Y	Y	Y	-	-	-
7	Pantnagar	Y	Y	Y	Y	Y	Y	Y	Y	-	-	Y
8	Udaipur	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y
9	Hyderabad	-	-	-	-	-	-	-	-	Y	-	-

Y= data received in time; '-'= Trail not allotted

### Annexure II: Details of collaborator

Centre	Collaborator, Address
Akola	Prof.HS Gahukar, Sorghum Pathologist, Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola- 444104, Maharashtra
Coimbatore	Dr. Shivkumar, Head AICSIP, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu
Dharwad	Dr. YD Narayana, Sorghum Pathologist, Main Sorghum Research Station, University of Agricultural Sciences, Dharwad-580005, Karnataka
Palem	Dr. Ameer Basha, Asst. Research Officer, Plant Pathology, ANGRAU Regional Agricultural Research Station, Palem-509125, Andhra Pradesh
Pantnagar	Dr. Yogendra Singh, Senior Research Officer, CAS in Plant Pathology, College of Agricultural GB Pant University of Agriculture & Technology, Pantnagar-263145, Uttarakhand
Parbhani	Dr. RW Deshmukh Pathologist, (Looking after pathology works in absence of Dr. V Mulekar, Pathologist), AICSIP, Marathwada Agriculture University, Parbhani-413722, Maharashtra.
Solapur	Dr TG Nageswar Rao, Centre for Rabi Sorghum, NH 9, Selgi, Solapur-413006, Maharashtra
Surat	Dr G R Bhandari, Pathologist, Main Sorghum Research Station, Gujarat Agricultural University, Surat-397007, Gujarat
Udaipur	Dr. RN Bunker, Sorghum pathologist, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture & Technology, Udaipur-313001, Rajasthan

### Annexure III: Disease resistant and susceptible checks

Checks	Grain Mold	SDM	Rust	Anthracnose	Zonate LS	Leaf blight
IS 14332	R	R	R	R	MR	R
B58586	R		R	R	MR	R
Bulk Y	S		S		S	
296B	S	R	R	R	MR	R
QL 3		R	S		S	
DMS 652		S	S		S	
H 112	S	S	S	S	MR	S
IS 2312			R	MR	S	R
Kekri Local	R	S	S	S	S	S
Rampur Local	R			S	S	
Pant Chari				R	R	
SSG 59-3			R	MR	S	MR

R= resistance, S= susceptible, MR= moderately resistance

Annexure IV: Centre-wise disease incidence record as received

sr	Parameters	Akola								Parbhani							
		AHT	AVT	IHT	IVT	IVTSC	AVTSC	MC	SS	AHT	AVT	IHT	IVT	IVTSC	AVTSC	MC	SS
1	Flowering	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
2	GM PGS	√	√	√	√	√	√	√	√	√	√	√	√	sp-in	sp-in	sp-in	sp-in
3	GM TGS	√	√	√	√	√	√	√	√	√	√	√	√	sp-in	sp-in	sp-in	sp-in
4	Fusarium	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
5	Curvularia	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
6	Other fungi	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
7	Germination	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
8	Seed wt	√	√	√	√		√	√	√								
9	SDM					no-in	no-in		no-in								
10	Ergot					no-in	no-in		no-in								
11	Anthraxnose	no-in	no-in	no-in	no-in	sp-in	sp-in	sp-in	sp-in	no-in	sp-in		sp-in	no-in	no-in	no-in	no-in
12	Zonate LS	sp-in	sp-in	sp-in	sp-in	sp-in	√	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	no-in	no-in	sp-in	sp-in
13	Leaf Blight	no-in	no-in	no-in	no-in	sp-in	sp-in	sp-in	√	√	√	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in
14	Rust	no-in	no-in	no-in	no-in		sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in
15	Sooty Stripe	√	√	√	√	√	√	√	√								
16	Rough LS	no-in	no-in	no-in	no-in	sp-in	√	sp-in	√	√	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in
17	Grey LS	sp-in	sp-in	sp-in	sp-in	sp-in	√	sp-in	√	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in
18	Target LS					no-in	no-in		no-in								
sr	Parameters	Dharwad								Surat							
		AHT	AVT	IHT	IVT	IVTSC	AVTSC	MC	SS	AHT	AVT	IHT	IVT	IVTSC	AVTSC	MC	SS
1	Flowering	√	√	√	√	NA	NA	NA	NA	√	√	√	√	√	√	√	√
2	GM PGS	√	√	√	√	NA	NA	NA	NA	√	√	√	√				√
3	GM TGS	√	√	√	√	NA	NA	NA	NA	√	√	√	√				√
4	Fusarium					NA	NA	NA	NA								
5	Curvularia					NA	NA	NA	NA								
6	Other fungi					NA	NA	NA	NA								
7	Germination					NA	NA	NA	NA								
8	Seed wt					NA	NA	NA	NA								
9	SDM	√	√	√	√	NA	NA	NA	NA	no-in	no-in	no-in	no-in	no-in	no-in	no-in	no-in
10	Ergot	no-in	no-in	no-in	no-in	NA	NA	NA	NA	√	√	√	√				√
11	Anthraxnose	no-in	no-in	no-in	no-in	NA	NA	NA	NA	√	√	√	√	√	√	√	√
12	Zonate LS	√	√	√	√	NA	NA	NA	NA					√	√	√	√
13	Leaf Blight					NA	NA	NA	NA	√	√	√	√	√	√	√	√
14	Rust	√	sp-in	sp-in	sp-in	NA	NA	NA	NA	no-in	no-in	no-in	no-in	no-in	no-in	no-in	no-in
15	Sooty Stripe					NA	NA	NA	NA								
16	Rough LS					NA	NA	NA	NA								
17	Grey LS					NA	NA	NA	NA								
18	Target LS					NA	NA	NA	NA	no-in	no-in	no-in	no-in	no-in	no-in	no-in	no-in

√ = Good incidence, sp-in = sporadic incidence, no-in = no incidence reported, blank cell= No information supplied, NA= Trial not allotted

Contd...

		Palem								Coimbatore							
sr	Parameters	AHT	AVT	IHT	IVT	IVTSC	AVTSC	MC	SS	AHT	AVT	IHT	IVT	IVTSC	AVTSC	MC	SS
1	Flowering					NA	NA	NA		√	√	√	√	√	√	√	NA
2	GM PGS	√	√	√	√	NA	NA	NA	sp-in	sp-in	sp-in	sp-in	sp-in				NA
3	GM TGS	√	√	√	√	NA	NA	NA	sp-in	sp-in	sp-in	sp-in	sp-in				NA
4	Fusarium	√	√	√	√	NA	NA	NA	no-an								NA
5	Curvularia	√	√	√	√	NA	NA	NA	no-an								NA
6	Other fungi	√	√	√	√	NA	NA	NA	no-an								NA
7	Germination	√	√	√	√	NA	NA	NA	√								NA
8	Seed wt	√	√	√	√	NA	NA	NA	√								NA
9	SDM					NA	NA	NA		√	√	sp-in	√	sp-in	sp-in	sp-in	NA
10	Ergot					NA	NA	NA		no-in	no-in	no-in	no-in				NA
11	Anthracoese					NA	NA	NA		√	sp-in	√	√	√	√	√	NA
12	Zonate LS					NA	NA	NA									NA
13	Leaf Blight					NA	NA	NA		√	sp-in	√	√	√	√	√	NA
14	Rust					NA	NA	NA		no-in	no-in	no-in	no-in	no-in	no-in	no-in	NA
15	Sooty Stripe					NA	NA	NA									NA
16	Rough LS					NA	NA	NA									NA
17	Grey LS					NA	NA	NA									NA
18	Target LS					NA	NA	NA									NA
		Pantnagar								Udaipur							
sr	Parameters	AHT	AVT	IHT	IVT	IVTSC	AVTSC	MC	SS	AHT	AVT	IHT	IVT	IVTSC	AVTSC	MC	SS
1	Flowering																
2	GM PGS																
3	GM TGS																
4	Fusarium																
5	Curvularia																
6	Other fungi																
7	Germination																
8	Seed wt																
9	SDM																
10	Ergot																
11	Anthracoese	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
12	Zonate LS	√	√	√	√	√	√	√	√					√	√	√	
13	Leaf Blight									√	√	√	√	√	√	√	√
14	Rust									sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in	sp-in
15	Sooty Stripe																
16	Rough LS																
17	Grey LS																
18	Target LS																

√ = Good incidence, sp-in = sporadic incidence, no-in = no incidence reported, blank cell= No information supplied, NA= Trial not allotted

### Appendix 1.1: Diseases and causal organisms

Grade	Disease	Causal organism
1	Grain mold	<i>Fusarium moniliforme</i> , J. Sheld; <i>Curvularia lunata</i> , <i>Phoma sorghina</i> & other
2	Downy mildew	<i>Peronosclerospora sorghi</i> (W. Weston & Uppal ) C. G. Shaw
3	Ergot/Sugar diseases	<i>Sphacelia sorghi</i> Mc Rae
4	Charcoal rot	<i>Macrophomina phaseolina</i> Tassi. Goid
5	Rust	<i>Puccinia sorghi</i> Cooke
6	Anthraxnose	<i>Colletotrichum graminicola</i> (Ces G.W. Wils )
7	Leaf blight	<i>Exserohilum turcicum</i>
8	Zonate leaf spot	<i>Gloeocercospora sorghi</i> Bain & Edgerton ex Deighton
9	Rough leaf spot	<i>Aschochyta sorghi</i> Sacc
10	Gray leaf spot	<i>Cercospora sorghi</i> Ellis & Everh
11	Sooty stripe	<i>Ramulispora sorghi</i> (Ellis & Everh ) Olive & Lefebvre in Olive et.al.
12	Target leaf spot	<i>Bipolaris sorghi</i> (Sacc ) Shoemaker.

### Appendix 1.2: Grades for estimation of diseases

**Grain mold:** *Field grade/Panicle grain mold rating (PGS), Threshed grade/threshed grain mold rating (TGS)*

Severity Grade	Description (% grains molded on panicle)	Disease Reaction
1	0 to <1	Highly Resistant
2	1-5	Resistant
3	6-10	Resistant
4	11-20	Moderately resistant
5	21-30	Moderately resistant
6	31-40	Susceptible
7	41-50	Susceptible
8	51-75	Highly Susceptible
9	>75	Highly Susceptible

#### *Ergot (incidence)*

Grade	Description (% panicle infected)	Disease Reaction
1	0 to <1	Highly Resistant
2	1-5	Resistant
3	6-10	Resistant
4	11-20	Moderately resistant
5	21-30	Moderately resistant
6	31-40	Susceptible
7	41-50	Susceptible
8	51-75	Highly Susceptible
9	>75	Highly Susceptible

**Foliar Diseases:** *(anthracnose, zonate leaf spot, leaf blight, rust, sooty stripe, grey leaf spot, target leaf spot)*

Grade	Description	Disease Reaction
1	No symptoms seen on the leaf and perfectly healthy	Highly Resistant
2	1-5% of the leaf area is affected by spot	Resistant
3	6-10% of the leaf area is affected by spot	Resistant
4	11-20% of the leaf area is affected by spot	Moderately resistant
5	21-30% of the leaf area is affected by spot	Moderately resistant
6	31-40% of the leaf area is affected by spot	Susceptible
7	41-50% of the leaf area is affected by spot	Susceptible
8	51-75% of the leaf area is affected by spot	Highly Susceptible
9	>75% of the leaf area is affected by spot	Highly Susceptible

**Downy mildew:** Calculate in per cent term for systemically infected plants.

**Charcoal rot:**

1. Charcoal rot (%) i.e., Number of plants infected/ total number of plants in a row.
2. Lodging due to charcoal rot (%)
3. Mean number of nodes crossed by the pathogen (number)
4. Mean length of spread of lesion (cm)