

Sorghum Pathology - Rabi 2016-17

IK Das, KK Sharma, VM Gholve, SN Chattannavar and S Jayalakshmi

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EXECUTIVE SUMMARY

Disease situation

Disease situation in farmer's field was surveyed in Maharashtra and Karnataka. Survey showed prevalence of few foliar and stalk diseases. Among foliar diseases leaf blight was moderate (3.5), rust was low (3.0 on 1-9 scale) and stalk disease charcoal rot incidence was around 22%. In Marathwada region charcoal rot incidence ranged from 15 to 27% in farmers' field and no other diseases except minor incidence of grain smut was reported from this region. In experimental conditions diseases like charcoal rot, downy mildew, leaf blight and rust were noted at different locations. Incidence of charcoal rot was noted across the rabi sorghum regions and disease severity was moderate to severe (CR index 19 to 27). Crop lodging was common in experimental plots (13 to 41%) and also in farmers' field. Low and sporadic incidence of downy mildew were noted only in Solapur region (range, 0 to 2.5%). Medium incidence of leaf diseases like rust and leaf blight was reported from Solapur center but not from any other locations.

Charcoal rot: Sixty-seven rabi sorghum varieties and hybrids were evaluated for charcoal rot resistance in hot spot locations in Maharashtra and Karnataka. Ranges of charcoal parameters in different locations were- incidence 10 to 42%, mean node cross 1.3 to 3.8 (1-9 scale) and CR index 19 to 27 (min 1, max 80). Most of the test entries behaved as moderately resistant while a few were susceptible to charcoal rot. Promising entries for CR resistance under deep soil conditions were Variety: SPV 2408, SPV 2412, and SPV 2471 (CR index 22 to 23); Hybrid: SPH 1801, SPH 1872, SPH 1864 and SPH 1867 (CR index 19 to 23). Promising entries in shallow soil were Variety: SPV 2418, SPV 2486, SPV 2484, SPV 2489 (CR index 22) and Hybrid: SPH 1802, SPH 1874, SPH 1875, (CR index 20 to 23).

Other diseases: Foliar diseases incidence was low to moderate and sporadic due to dry weather conditions. Leaf rust and blight severity were moderate (range 2.7 to 6.6 on 1-9 scale) in experimental plots at Solapur while the downy mildew and viral diseases were sporadic in nature and minor in severity. The test variety SPV 2348 and the test hybrids SPH 1872, SPH 1869, SPH 1870, SPH 1802 and SPH 1833 were promising for leaf rust resistance (≤ 3.0 , 1-9 scale) and were promising.

Stay green: Stay green is an important character that imparts charcoal rot resistance to sorghum genotype. Top five leaves are observed for greenness at the time of maturity. Number of green leaf per plant was counted entry wise and data were analyzed. Number of green leaf at maturity ranged from 1.2 – 4.0 (min 1, max 5). The test varieties SPV 2405, SPV 2468, SPV 2472, SPV 2479, SPV 2478, SPV 2348, SPV 2486 and SPV 2490 and the test hybrids, SPH 1801, SPH 1866, SPH 1834, SPH 1864 and SPH 1802 recorded more than 2.5 green leaves at maturity.

Crop lodging: Crop lodging incidence in this season was medium to high at different locations. High crop lodging was reported from Parbhani (29%) and Gulbarga (36%) while it was low at Solapur (16%). The test hybrids SPH 1864, SPH 1802 and SPH 1875 were promising for lodging resistance (<20%).

Flowering time: Number of days taken to 50% flowering varied from 68 to 78 among entries (national mean). Among the test entries none flowered before 70 days or after 77 days. There were variations in flowering time at different locations as shown by location means. Flowering took less time at Dharwad (~70 days) and more at Parbhani (~80 days). Few early to flower test hybrids were SPH 1865, SPH 1866, SPH 1863 and SPH 1864 (≤ 70 days). None of the test varieties flowered in ≤ 70 days.

Charcoal rot nursery: Ten entries were evaluated for charcoal rot resistance at four hot spot locations. CR index varied from 8.7 to 38.2 suggesting resistant to susceptible CR reactions. On national mean CR index varied from 16.9 to 24.5 indicating moderately resistant CR reactions for the test entries and they were not significantly different. The entries RSV1842, RSV1976 and RSV1945 recorded relatively less charcoal rot (CR index <20). RSV 1842 was short in height (134 cm) and possessed 2.5 green leaves at maturity. RSV1976 and RSV1945 were medium in height (~175 cm) and had bold grains (~3.0g/100).

DETAILED REPORT

Disease situation

During rabi 2015-16 season diseases like charcoal rot, rust, downy mildew and leaf blight were noted at different locations. Incidence of charcoal rot was noted across the rabi sorghum areas Parbhani, Solapur, Dharwad, Bijapur and Gulbarga and disease severity was moderate to severe (19 to 27 CR index). Crop lodging was common and reported Parbhani, Solapur and Gulbarga areas in experimental plots (13 to 41%). Low and sporadic incidence of downy mildew were noted only in Solapur region (range, 0 to 2.5%). Medium incidence of leaf diseases like rust and leaf blight was reported from Solapur center but not from any other locations.

Survey of farmers' fields showed prevalence of few foliar diseases especially rust during late stage of the crop growth. In Marathwada region in Maharashtra charcoal rot incidence ranged from 15 to 27 % in farmers' field and no other sorghum diseases except minor incidence of grain smut was reported from this regions.

Multi-locations varietal and hybrid trials

Advanced and Initial trial materials were evaluated for rabi diseases in hot spots locations. Charcoal rot (CR) is common across locations during rabi season and other diseases like downy mildew and leaf diseases are observed in sporadic form. Evaluation for CR resistance was undertaken in endemic areas at Bijapur, Gulbarga, Parbhani and Solapur, in *Macrophomina phaseolina* sick soils under rabi conditions. CR incidence was measured as percentage of plants showing CR symptoms in an entry [CR incidence (%) = (Number of CR infected plants/ Total number of plants) x 100]. Severity was measured on a 1–5 scale based on number of internodes crossed by the rot symptoms (1 = one internode invaded, but rot does not pass through any nodal area, 2 = two, 3 = three, 4 = four and 5 = more than four internodes extensively invaded, shredding of stalk and death of plant). Other parameters considered were mean length of spread of lesion (MLS, cm) and percent lodging due to charcoal rot. As incidence and severity both are important to judge CR resistance/susceptibility of a line, charcoal rot index was calculated combining incidence and severity both using a formula. Important values of CR index are CR index ≤10 Resistance, 11-25 Moderately Resistant, 26-40 Susceptible, and >40 Highly Susceptible.

During rabi 2016-17 there was moderate CR index at Parbhani (18.9) and Solapur (19.0) and moderate to severe at Dharwad (26.4), Bijapur (24.8) and Gulbarga (27.3) (Fig.1).

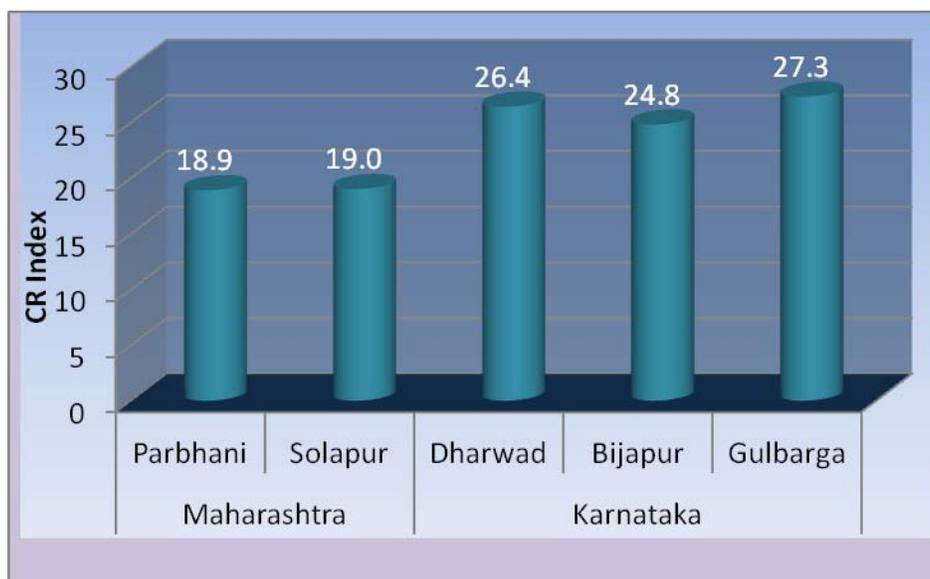


Fig.1. Charcoal rot index for different locations during Rabi 2016-17

1. Initial and Advanced Hybrid Trial - Deep soil

Nineteen entries that included 13 test hybrids, 3 national checks, 1 local check and 2 disease resistant and susceptible checks were evaluated against charcoal rot and foliar diseases.

Charcoal rot: Mean charcoal rot incidence on IAHT-DS trial was medium at Parbhani (19.5%) and Solapur (13.9%) and quite high at Dharwad (45.2%), Bijapur (39.1%) and Gulbarga (24.7%) (Table 1.2). CR incidence differed significantly among the entries at all locations. Incidence ranged from 17.6% to 33.5% across genotypes in all India mean. Top five lines with less CR incidence were Local check, SPH 1867, SPH 1801, SPH 1872 and SPH 1871 (25.8 to 27.1%).

CR Severity that indicates the extent of stalk-tissue damage [Mean number of node crossed or MNC (Nos) & Mean length of lesion spread (cm)] depends on many factors including soil moisture, stalk characters and stay-green properties of the plant. CR severity varied among the locations and it was low at Bijapur (MNC=1.3 & MLS 10.9), moderate at Parbhani (2.5 & 19.5) and Dharwad (2.3 & 13.9) and severe at Solapur (3.7 & 25.8) and Gulbarga (2.8 &

24.7) (Table 1.1 & 1.2). On all India bases, entries differed significantly for MNC and MLS. MNC ranges from 2.0 (E36-1) to 3.0 (CSH 13R). Top five lines with less MNC were SPH 1801, SPH 1837, SPH 1865, SPH 1834 and SPH1864 (2.0 to 2.4).

CR index, which combines both incidence (CR %) and severity (MNC & MLS) is a better indicator of CR reaction of an entry than the incidence or severity alone. The index for different locations ranged 18.9 (Parbhani) to 27.4 (Gulbarga). Except at Dharwad location, CR index differed significant among the entries. On national mean it varied from 14.1 (E36-1) to 26.9 (SPH 1866) suggesting moderately resistant to susceptible CR reactions for entries (Table 1.1). Top five lines with less CR index were SPH 1801, SPH 1872, SPH 1864, SPH 1867 and SPH 1868 (18.5 to 22.8).

Overall the promising entries in the trial IAHT-deep soil for charcoal rot resistance were SPH 1801, SPH 1872, SPH 1864, and SPH 1867.

Crop lodging: Crop lodging was reported from Parbhani, Solapur and Gulbarga. Parbhani (24.6%) and Solapur (18.2%) recorded moderate lodging while lodging in Gulbarga was severe (40.6%). Entries showed significant differences in lodging in all the locations. Top five entries with less lodging were SPH 1864, SPH 1801, SPH 1867, SPH 1868 and SPH 1869 (16 to 25%) (Table 1.3).

Stay green: Stay green is an important character that imparts charcoal rot resistance to sorghum genotype. Top five leaves per plant were observed for greenness at the time of maturity. Number of green leaf was counted entry wise and data were analyzed. Solapur and Parbhani recorded stay green data. Mean number of green leaf at Solapur varied from 1.3 to 2.9 (out of max 5) (Table 1.3). Top five entries with more green leaf area in Solapur at maturity were SPH 1801, SPH 1866, SPH 1834, SPH 1864 and Local check (2.9 to 2.5).

Leaf diseases: Because of dry season foliar diseases incidence was in traces in most of the locations except Solapur. At Solapur moderate incidence of leaf blight (mean 4.4 on 1-9 scale; range 3.7 to 5.3) and moderate to severe incidence of leaf rust (mean 4.5; range 1.0 to 7.3) was recorded (Table 1.3), while downy mildew and viral diseases were sporadic in appearance (0 to 2.5%) on a few entries. The entries SPH 1872, SPH 1869 and SPH 1870 were resistant to leaf rust (1.0 to 3.0).

Flowering time: Days to 50% flowering was recorded at Parbhani, Solapur, Dharwad, Bijapur and Gulbarga. Location means varied from 69.7 (Solapur) to 80.7 (Parbhani) days with national mean 72.8 days (Table 1.2). Data was significant at 5% level across locations except Dharwad and Bijapur. Early genotypes generally escape charcoal rot because of less soil moisture stress. On national average, top five early entries were CSH 15R, SPH 1865, SPH 1866, SPH 1863 and SPH 1864 (69.0 to 70.9 days).

Plant height: Plant height was recorded at Parbhani, Dharwad, Bijapur and Gulbarga. Mean plant height in these locations was 166.3 cm (Parbhani), 178.1 cm (Dharwad), 148.1 cm (Bijapur) and 144.1 cm (Gulbarga) (Table 1.2). Height differences were significant at 5% level in all locations. Shorter genotypes generally lodge less than the taller one. On national average, top five short height entries were SPH 1837, SPH 1872, CSH 13R, SPH 1871 and SPH 1870 (129.5 to 157.2 cm).

Grain yield: Grain yield was recorded at Parbhani, Solapur and Gulbarga. Entries did not differ significant at 5% level on nation average (range 1.1 to 1.4 Kg/plot) (Table 1.3). On national mean, top five entries with more grain yield were CSH 13R, CSH 15R, SPH 1870, SPH 1863 and SPH 1871 (1.3 to 1.4 Kg/plot).

Seed weight: 100 seed weight was recorded at Parbhani, Solapur and Gulbarga. Data was significant at 5% level across locations except Parbhani (Table 1.3). On national mean 100 seed weight varied from 2.1 (CSH 13R) to 3.3 (SPH 1864) and differences were statistically significant. Entries with 100 seed weight >3.0g were SPH 1801, SPH 1863, SPH 1864, SPH 1865, SPH 1867, SPH 1868 SPH 1869, SPH 1871 and Local check.

2. Initial and Advanced Varietal Trial - deep soil

Twenty-five entries that included 19 test hybrids, 3 national checks, 1 local check and 2 disease resistant and susceptible checks were evaluated against charcoal rot and foliar diseases.

Charcoal rot: Mean charcoal rot incidence on IAVT-DS trial was medium at Gulbarga (22.0%) and Solapur (12.7%) and high at Dharwad (42.0%), Bijapur (42.0%) and Parbhani (24.5%) (Table 2.2). CR incidence differed significantly among the entries at all locations except Solapur. On all India mean, incidence ranged from 16% to 33% across genotypes. Top five entries with less CR incidence were SPV 2412, SPV 2471, SPV 2408, Local check and SPV 2477 (24 to 27%).

CR Severity that indicates the extent of stalk-tissue damage [Mean number of node crossed or MNC (Nos) & Mean length of lesion spread (cm)] depends on many factors including soil moisture, stalk characters and stay-green properties of the plant. CR severity varied among the locations and it was low at Bijapur (MNC=1.9 & MLS 16.2), moderate at Parbhani (2.6 & 18.0) and Gulbarga (2.3 & 27.4) and severe at Solapur (3.8 & 30.2) and Dharwad (2.9 & 20.0) (Table 2.1 & 2.2). On all India bases, entries differed significantly for MNC and MLS. MNC ranged from 2.2 (E36-1) to 3.2 (SPV 2480). Top five lines with less MNC were SPV 2408, Local check, SPV 2405, M35-1 and CSV 22 (2.2 to 2.5).

CR index, which combines both incidence (CR %) and severity (MNC & MLS) is a better indicator of CR reaction of an entry than the incidence or severity alone. The index for different locations ranged 20.6 (Parbhani) to 28.8 (Dharwad). Except at Solapur location, CR index differed significant among the entries. On national mean it varied from 15.6 (E36-1) to 26.3 (M35-1) suggesting moderately resistant to susceptible CR reactions for entries (Table 2.1). Top five lines with less CR index were Local check, SPV 2408, SPV 2412, SPV 2474 and SPV 2471 (21.1 to 23.2).

Overall the promising entries in the trial IAVT-deep soil for charcoal rot resistance were SPV 2408, SPV 2412, and SPV 2471.

Crop lodging: Crop lodging was reported from Parbhani, Solapur and Gulbarga. Solapur recorded low-medium lodging (16%) while Parbhani (32.8%) and Gulbarga (37.8%) reported high crop lodging. Entries showed significant differences in lodging in all the locations. Top five entries with less lodging were SPV 2474, SPV 2412, SPV 2471, SPV 2405 and SPV 2468 (21.2 to 25.4%) (Table 2.3).

Stay green: Stay green is an important character that imparts charcoal rot resistance to sorghum genotype. Top five leaves per plant were observed for greenness at the time of maturity. Number of green leaf was counted entry wise and data were analyzed. Solapur and Parbhani recorded stay green data. Mean number of green leaf at Solapur varied from 1.7 (SPV 2475) to 3.6 (SPV 2405) (out of max 5) (Table 2.3). Top five entries with more green leaf area in Solapur at maturity were SPV 2405, SPV 2468, SPV 2472, SPV 2479 and SPV 2478 (2.9 to 3.6).

Leaf diseases: Because of dry season foliar diseases incidence was in traces in most of the locations except Solapur. At Solapur moderate incidence of leaf blight (mean 5.1 on 1-9 scale; range 4.3 to 5.7) and leaf rust (mean 5.2; range 1.0 to 7.3) was recorded (Table 1.3), while downy mildew and viral diseases were sporadic in appearance (0 to 2.5%) on a few entries. The entries SPV 2476 and SPV 2481 were promising for leaf rust resistance (3.3 to 4.0).

Flowering time: Days to 50% flowering was recorded at Parbhani, Solapur, Dharwad, Bijapur and Gulbarga. Location means varied from 73.2 (Gulbarga) to 82.2 (Parbhani) days with national mean 76.1 days (Table 2.2). Data was significant at 5% level across locations except Dharwad. Early genotypes generally escape charcoal rot because of less soil moisture stress. On national average, top five early entries were SPV 2475, Local check, SPV 2405, SPV 2476 and SPV 2469 (74.1 to 75.4 days).

Plant height: Plant height was recorded at Parbhani, Dharwad, Bijapur and Gulbarga. Mean plant height in these locations was 186 cm (Parbhani), 191 cm (Dharwad), 156 cm (Bijapur) and 138 cm (Gulbarga) (Table 2.2). Height differences were significant at 5% level in all locations. Shorter genotypes generally lodge less than the taller one. On

national average, top five short height entries were SPV 2473, SPV 2470, SPV 2476, SPV 2474 and SPV 2477 (156 to 162 cm).

Grain yield: Grain yield was recorded at Parbhani, Solapur and Gulbarga. Entries differed significant at 5% level on nation average (range 1.66 to 1.44 Kg/plot) (Table 2.3). On national mean, top five entries with more grain yield were SPV 2470, SPV 2471, SPV 2473, CSV 22 and M35-1 (1.38 to 1.44 Kg/plot).

Seed weight: 100 seed weight was recorded at Parbhani, Solapur and Gulbarga. Data was significant at 5% level across locations except Parbhani (Table 2.3). On national mean 100 seed weight varied from 2.7 (SPV 2480) to 3.2 (E36-1) but differences were not statistically significant. Entries with 100 seed weight >3.0g were SPV 2412, SPV 2470 and SPV 2481.

3. Initial and Advanced Varietal and Hybrid Trial - shallow soil

Twenty-nine entries that included 8 test hybrids, 13 test varieties 6 national checks and 2 disease resistant and susceptible checks were evaluated against charcoal rot and foliar diseases.

Charcoal rot: Mean charcoal rot incidence on IAVHT-SS trial was low at Solapur (7.9%), medium at Gulbarga (23.3%) and Parbhani (22.3%) and high at Dharwad (33.8%) and Bijapur (42.8%) (Table 3.2). CR incidence differed significantly among the entries at all locations. On all India mean, incidence ranged from 19.0% to 35.5% across genotypes. Top five entries with less CR incidence were SPH 1875, SPH 1802, SPV 2486, SPV 2489 and CSV 26 (22.3 to 23.3%).

CR Severity that indicates the extent of stalk-tissue damage [Mean number of node crossed or MNC (Nos) & Mean length of lesion spread (cm)] depends on many factors including soil moisture, stalk characters and stay-green properties of the plant. CR severity varied among the locations and it was low at Bijapur (MNC=1.6 & MLS 13.7), moderate at Parbhani (2.7 & 21.4) and Dharwad (2.6 & 16.6) and severe at Solapur (3.4 & 19.9) and Gulbarga (2.9 & 24.9) (Table 3.1 & 3.2). On all India bases, entries differed significantly for MNC and MLS. MNC ranged from 2.1 (E36-1) to 3.0 (SPV 2485). Top five lines with less MNC were SPV 2418, Phule Anuradha, SPH 1875, SPV 2488 and SPV 2484 (2.3 to 2.5).

CR index, which combines both incidence (CR %) and severity (MNC & MLS) is a better indicator of CR reaction of an entry than the incidence or severity alone. The index for different locations ranged 15.1 (Solapur) to 30.2 (Gulbarga). CR index differed significant among the entries in all the locations. On national mean it varied from 14.0 (E36-1) to 30.2 (SPV 2490) suggesting resistant to susceptible CR reactions for entries (Table 3.1). Top five lines with less CR index were SPH 1802, P Anuradha, CSV 26, SPV 2418, SPV 2486, SPV 2489 and SPV 2484 (19.5 to 21.8).

Overall the promising entries in the trial IAVHT-shallow soil for charcoal rot resistance were SPH 1802, SPV 2418, SPV 2486, SPV 2489 and SPV 2484.

Crop lodging: Crop lodging was reported from Parbhani, Solapur and Gulbarga. Solapur recorded low lodging (12.5%) while Parbhani (39.2%) and Gulbarga (39%) reported high crop lodging. Entries showed significant differences in lodging in all the locations. SPH 1833 was susceptible to lodging (47.2%). Top five entries with less lodging were E36-1, SPH 1875, SPH 1802, SPV 2416 and SPH 1836 (16.1 to 23.1%) (Table 3.3).

Stay green: Stay green is an important character that imparts charcoal rot resistance to sorghum genotype. Top five leaves per plant were observed for greenness at the time of maturity. Number of green leaf was counted entry wise and data were analyzed. Solapur and Parbhani recorded stay green data. Mean number of green leaf at Solapur varied from 1.8 (M35-1) to 4.0 (SPH 1802) (out of max 5) (Table 3.3). Top five entries with more green leaf area in Solapur at maturity were SPH 1802, SPV 2348, SPV 2486, SPV 2490 and E36-1 (2.9 to 4.0).

Leaf diseases: Because of dry season foliar diseases incidence was in traces in most of the locations except Solapur. At Solapur moderate incidence of leaf blight (mean 4.4 on 1-9 scale; range 3.3 to 5.0) and leaf rust (mean

3.7; range 1.3 to 5.0) was recorded (Table 3.3), while downy mildew was sporadic in appearance (0 to 2.5%) on a few entries. The entries SPH 1802, SPH 1833 and SPV 2348 were promising for leaf rust resistance (2.0 to 2.7).

Flowering time: Days to 50% flowering was recorded at Parbhani, Solapur, Dharwad, Bijapur and Gulbarga. Location means varied from 69.9 (Dharwad) to 81.5 (Parbhani) days with national mean 74.0 days (Table 3.2). Data was significant at 5% level across locations except Dharwad. Early genotypes generally escape charcoal rot because of less soil moisture stress. On national average, top five early entries were P Anuradha, E36-1, SPV 2416, SPH 1835 and SPH 1833 (68.0 to 72.4 days).

Plant height: Plant height was recorded at Parbhani, Dharwad, Bijapur and Gulbarga. Mean plant height in these locations was 164.8 cm (Parbhani), 181.4 cm (Dharwad), 149.3 cm (Bijapur) and 138.5 cm (Gulbarga) (Table 3.2). Height differences were significant at 5% level at Parbhani and Dharwad locations. Shorter genotypes generally lodge less than the taller one. On national average, top five short height entries were E36-1, SPV 2418, SPV 2348, SPH 1873 and CSH 13 (112 to 146 cm).

Grain yield: Grain yield was recorded at Parbhani, Solapur and Gulbarga. Entries did not differ significantly at 5% level on nation average (range 1.13 to 1.47 Kg/plot) (Table 3.3). On national mean, top five entries with more grain yield were SPH 1802, SPH 1805, Phule Anuradha, SPV 2490 and CSV 26 (1.32 to 1.47 Kg/plot).

Seed weight: 100 seed weight was recorded at Parbhani, Solapur and Gulbarga. Data was significant at 5% level at Solapur and Gulbarga locations (Table 3.3). On national mean 100 seed weight varied from 2.1g (SPV 2348) to 3.6g (SPH 1875). Top five entries with 100 seed weight >3.0g were SPH 1875, Phule Anuradha, SPH 1873, SPH 1805 and SPH 1802 (3.4 to 3.6g).

Performance of entries against charcoal rot

Trials	CR index for Checks	CR index ≤ 10 (Res)	CR index 11-25 (Mod Res)	CR index ≥ 25 (Sus)	Top few test varieties & hybrids
IAHT-deep soil	CSH 13 K&R (26) CSH 15R (26) M35-1 (26) Local check (23)	None	All except SPH 1866, SPH 1870	SPH 1866, SPH 1870	Hybrid: SPH 1801, SPH 1872, SPH 1864 and SPH 1867 (19 to 23)
IAVT-deep soil	M35-1 (26), CSV 29R (26), CSV 22 (25), Local check (21)	None	SPV 2405, SPV 2407, SPV 2408, SPV 2412, SPV 2469, SPV 2470, SPV 2471, SPV 2473, SPV 2474, SPV 2476, SPV 2477, SPV 2481	SPV 2406, SPV 2468, SPV 2472, SPV 2475, SPV 2478, SPV 2479, SPV 2480	Variety: SPV 2408, SPV 2412, and SPV 2471 (22 to 23)
IAVHT-shallow soil	M35-1 (25), CSV 26 (21), CSH 15R (26), Phule Anuradha (20), Phule Maulee (23),	None	All, except SPV 2483 and SPV 2485	SPV 2483, SPV 2485	Variety: SPV 2418, SPV 2486, SPV 2484, SPV 2489 (22) Hybrid: SPH 1802, SPH 1874, SPH 1875, (20 to 23)

Charcoal rot nursery

Thirteen entries that included 10 test entries and 3 checks including resistant and susceptible checks were evaluated against charcoal rot and foliar diseases.

Charcoal rot: Entries were tested at Parbhani, Solapur Dharwad and Gulbarga. Mean charcoal rot incidence on was low at Parbhani (13.3%) and Solapur (10.8%), medium at Gulbarga (22.2%) and high at Dharwad (39.1%) (Table 4.2). CR incidence did not differ significantly among the entries at these locations. Incidence ranged from 18.3%

(RSV 1986) to 25.1% (M35-1) across genotypes in all India mean. Top three lines with less CR incidence were RSV1986, RSV1911 and RSV1842 (18.3 to 19.6%).

CR Severity that indicates the extent of stalk-tissue damage [Mean number of node crossed or MNC (Nos) & Mean length of lesion spread (cm)] depends on many factors including soil moisture, stalk characters and stay-green properties of the plant. CR severity varied among the locations and it was medium at Parbhani (MNC=2.2 & MLS 15.1) and severe at Solapur (3.6 & 20.9), Dharwad (3.0 & 18.5) and Gulbarga (2.5 & 29.4) (Table 4.1 & 4.2). On all India bases, entries did not differ significantly for MNC and MLS. MNC ranges from 2.5 (CSV8R) to 3.1 (RSV 1736). Top three lines with less MNC were RSV 1976, RSV 1906 and RSV 1911 (2.6 to 2.6).

CR index, which combines both incidence (CR %) and severity (MNC & MLS) is a better indicator of CR reaction of an entry than the incidence or severity alone. The index for different locations ranged 14.4 (Parbhani) to 26.7 (Dharwad). CR index differed significant among the entries at Solapur and Dharwad and non-significant at Parbhani and Gulbarga. On national mean it varied from 16.9 (RSV 1842) to 24.5 (RSV 1876) suggesting moderately resistant reactions for entries (Table 4.1). Top three lines with less CR index were RSV1842, RSV1976 and RSV1945 (16.9 to 19.9).

Overall the promising entries for charcoal rot resistance were RSV1842, RSV1976 and RSV1945.

Crop lodging: Crop lodging was reported from Parbhani, Solapur and Gulbarga. Parbhani (18%) and Solapur (24%) recorded moderate lodging while lodging in Gulbarga was severe (38%). Entries did not show significant differences in lodging in all the locations. Top three entries with less lodging were RSV1906, RSV1945 and RSV1911 (18 to 21%) (Table 4.3).

Stay green: Stay green is an important character that imparts charcoal rot resistance to sorghum genotype. Top five leaves per plant were observed for greenness at the time of maturity. Number of green leaf was counted entry wise and data were analyzed. Solapur and Parbhani recorded stay green data. Mean number of green leaf at Solapur varied from 1.6 to 2.8 (out of max 5) (Table 4.3). Top three entries with more green leaf area in Solapur at maturity were RSV1842, RSV1940 and RSV1976 (2.3 to 2.4).

Leaf diseases: Because of dry season foliar diseases incidence was in traces in most of the locations except Solapur. At Solapur moderate incidence of leaf blight (mean 4.7 on 1-9 scale; range 4.0 to 5.0) and leaf rust (mean 4.9; range 2.7 to 6.3) was recorded (Table 4.3), while downy mildew and viral diseases were sporadic in appearance (0 to 2.5%) on a few entries.

Flowering time: Days to 50% flowering was recorded at Parbhani, Solapur, Dharwad, and Gulbarga. Location means varied from 71.4 (Dharwad) to 82.7 (Parbhani) days with national mean 75.1 days (Table 4.2). Data was significant at 5% level at Solapur. Early genotypes generally escape charcoal rot because of less soil moisture stress. On national average, top three early entries were RSV1736, E36-1 and RSV1876 (71 to 74 days).

Plant height: Plant height was recorded at Parbhani, Dharwad, and Gulbarga. Mean plant height in these locations was 182 cm (Parbhani), 182 cm (Dharwad) and 155 cm (Gulbarga) (Table 4.2). Height differences were significant at 5% level at Parbhani. Shorter genotypes generally lodge less than the taller one. On national average, top three short height entries were RSV1842, CSV 8R and RSV1945 (134 to 172 cm).

Grain yield: Grain yield was recorded at Parbhani, Solapur and Gulbarga. Entries did not differ significant at 5% level on nation average (range 1.1 to 1.4 Kg/plot) (Table 4.3). On national mean, top three entries with more grain yield were RSV1906, CSV 8R and E36-1 (1.43 to 1.47 Kg/plot).

Seed weight: 100 seed weight was recorded at Parbhani, Solapur and Gulbarga. Data was significant at 5% level at Solapur and Gulbarga (Table 4.3). On national mean 100 seed weight varied from 2.4 (RSV 1977) to 3.5 (RAV 1906) and differences were statistically significant. Entries with 100 seed weight >3.0g were RSV 1876, RSV 1906, RSV 1911, RSV 1986, E36-1 and CSV 8R.

Annexure I: Performance of the centers

S.No.	Centre	IAHT-deep	IAVT-deep	IAVHT- shallow	CRN
1	Bijapur	Y	Y	Y	-
2	Dharwad	Y	Y	Y	Y
3	Gulbarga	Y	Y	Y	Y
4	Parbhani	Y	Y	Y	Y
5	Solapur	Y	Y	Y	Y

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

Annexure II: Details of collaborator

Centre	Collaborator & Address
Solapur	Dr KK Sharma, Centre for Rabi Sorghum, NH 9, Shelgi, Solapur-413006, Maharashtra
Parbhani	Dr. VM Gholve, Pathologist, AICRP-Sorghum, Marathawada Agriculture University, Parbhani-413722, Maharashtra
Dharwad	Dr. SN Chattannarvar, Professor, Main Sorghum Research Station, University of Agricultural Sciences, Dharwad-580005, Karnataka
Bijapur	Dr. SN Chattannarvar, Looking after Pathology programme at Regional Agricultural Research Station, Bijapur-586 101, Karnataka
Gulbarga	Dr. S Jayalakshmi, Professor, AICRP on Sorghum, ARS, Gulbarga-585101, Karnataka

Appendix 1: Grades and estimation of diseases

Charcoal rot:

- (A) **CR Incidence:** Charcoal rot incidence is the proportion of plants showing charcoal rot infection in an entry. It is measured as percentage [CR incidence (%) = (Number of CR infected plants/ Total number of plants) x 100].
- (B) **CR Severity:** Charcoal rot severity is the proportion of stalk tissue damaged due to infection in an individual plant. It is measured on a 1–5 scale based on number of internodes crossed by the symptoms (1 = one internode invaded, but rot does not pass through any nodal area, 2 = two, 3 = three, 4 = four and 5 = more than four internodes extensively invaded, shredding of stalk and death of plant). As per disease reactions a score of 1 is resistant and 5 are highly susceptible.
Note: Mean length of spread of lesion (MLS, cm) is useful especially when intermodal length significantly differ among the entries.
- (C) **Charcoal rot index** = (Incidence x 0.4 + MNC x 0.6 x r)
r = MLS/MNC, depends on genotype. 'r' can be calculated based on database available for different locations. In cultivated rabi genotypes value of 'r' ranges from is 6 to 10. Important values of CR Index are CR Index ≤10 Resistance, 11-25 Moderately Resistant, 26-40 Susceptible, and >40 Highly Susceptible.

Downy mildew: Calculate in per cent term for systemically infected plants. Grade disease reactions as follows; Resistant = ≤5%; Moderately Resistant = 6-10% Susceptible = 11-30%; Highly Susceptible = ≥30%.

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