Sorghum entomology: Kharif, 2011

C o n t e n t s

Executive summary

Introduction: Genotypes received from AICSIP centers in the form of seven trials (AHT-GS & DP, AVT-GS & DP, , IHT- GS & DP, IVT- GS & DP , IVHT--MC, IAVT-SC, and IAVHT-SS) were evaluated for shoot fly, stem borer and other pests for resistance/tolerance at the respective hot-pot locations mainly Coimbatore, Dharwad, Palem, Rahuri, Parbhani, Akola, Indore, Surat, Hisar and Udaipur. Other than regular trials, pest specific trials three on shoot fly and two on stem borer were formulated with the team effort of entomology-breeding-germplasm and evaluated for susceptibility/resistance accordingly.

Pest scenario in sorghum: This year there was relatively low rainfall than normal rain fall in all most all centers. As a result, the pest incidence was moderate to higher particularly, at Akola, Parbhani, Dharwad, Udaipur; and stem borer at Dharwad, Hisar, Surat and Coimbatore. The peduncle damage and tunneling damage has shown increase in percent particularly in Parbhani, and Coimbatore. Very low incidence of midge (<5%) was recorded in Deesa, Dharwad and Coimbatore district. Among the ear head pests, *Calocoris angustatus* was noticed up to 10% in some parts of states. The panicle head worm and *Helicoverpa armigera* infested sorghum up to 10 %. The mite incidence was recorded at low level in Surat and Coimbatore area.

Shoot fly (*Atherigona soccata*, Rond): General trend: The shoot fly incidence was moderate to high (30-60%) at Dharwad, Parbhani, Akola, Indore, Surat and Udaipur.

Grain and dual purpose sorghum: In AHT-GS&DP, AVT-GS&DP, IHT-GS &DP and IVT-GS&DP none of the test entries found better than resistant check IS 2312 or IS 18551. The range was of deadhearts at 28 DAE was from 30.5-87.7%

Forage (multi cut): Across the locations and genotypes, the shoot fly damage at 28 DAE was from 31.2 to 87.5% being an average of 60.5%. No entry was on par with resistant check IS 18551. Resistant check recorded 31.2% DH.

Forage (single-cut): Across the locations and genotypes, the shoot fly damage at 28 DAE was from 31.2 to 88.9% being an average of 59.3%. Although the data was statistically significant at 5% level, only one entry (SPV 2057) was on par with resistant check.

Sweet sorghum: Across the zones and genotypes the entry SPV 2136 recorded lowest deadhearts % and was on par with resistant check. The damage range was 30.7-86.3% with an average of 58.9% at 28 DAE.

Shoot fly resistance nursery: Across the locations, the damage range was from 28.5-80.8% with mean of 45.9%. The entries 08 BSF 06, 08RAgro 01, NRCSFR08-3-C 43 x IS 18551, NRCSFR 09-3(296 B x IS 2122) x (296 B x IS 18551), NRCSFR11-4, SUENT 9, SUENT 26, EP 57, EP 58, EC 15, POP 52 and EP 96 were on par with resistant check IS 18551. The resistant check recorded 28.5 % DH at 28 DAE.

Northern based dual purpose sorghum (DP-SF): Across the locations, the damage range was from 27.1-73.9% with mean of 40.0%. The entries P 55, PGN 65, PFGS 45, P 48, ICSV 705, LAWA, LDR 218, LDR 238, LOCAL -5, M-35-1, P 29, P 41, P 45, PFGS 23, PGN 39, PGN 4 RED, PGN 45, PGN 53, PGN 66, PGN 75, RSE 03, RSSV 9, SUENT 13, and AKR 354 were on par with resistant check IS 2312. The resistant check recorded 27.1 % DH at 28 DAE.

National Genetic Stock Nursery for shoot fly (NGSN-SF): Five hundred and twenty five lines (including susceptible checks) were evaluated for susceptibility to shoot fly at three locations. Overall, the shoot fly deadheart range was 19.1 to 100 % being an average of 51.5%. The Germplasm that showed <25% deadhearts are EJ 37, EB 2, E 56, E 72, E 75, EG 5, VKG 34/66.

Overall conclusions: The four years data of shoot fly revealed that Dharwad, Parbhani, Rahuri, Akola and Udaipur centre may be considered for hot spot for shoot fly screening, further there is a need to record the data on plant population, seedling vigor, seedling glossiness, seedling height, chlorophyll content, days to flowering, effective tillering to interpret the findings in a more effective way especially in shoot fly trials.

Spotted stem borer (*Chilo partellus*, Swinhoe): General trend: The stem borer incidence was moderate to high. The highest damage was noticed at Hisar (~50 %). At Coimbatore, Surat, Indore and Hisar and Ludhiana moderate population was observed. The peduncle damage particularly at Dharwad, Coimbatore and Parbhani is increasing.

Grain and dual purpose sorghum: Across the locations and genotypes, the data was non-significant in AHT-GS&DP trial. The overall mean DH % due to stem borer at 45 DAE was 15.3% and the range was from 11.4 to 26.4%. All test entries except SPH 1679 was on par with resistant check IS 2205. In AVT-GS&DP, the test entries SPV 1999, SPV 2000, SPV 2079, SPV 2083, CSV 15, CSV 17 and SPV 462 were on par with resistant check IS 2205.In IHT-GS&DP, the locations and zones the overall mean DH % due to stem borer at 45 DAE was 12.1% and the damage ranged was from 6.0 – 23.7 %. SPH 1704 was on par with resistant check IS 2205. In IVT-GS&DP, the overall mean DH % due to stem borer at 45 DAE was 15.4 % and the range was from 8.3 – 26.7 %. The entries SPV 2115, SPV 2121, SPV 2119, SPV 2118, SPV 2122, SPV 2120 and SPV 2125 deadhearts on par with resistant check IS 2205 (8.3 %).

Forage (multi cut): The entries that recorded <15% damage are SPV 2107, SPV 2108, SSG 59-3, CSH20MF and local check. The mean DH was 16.2% being a range of 12.8-20.9 %.

Forage (single-cut): Across the locations and zones, overall the mean deadheart was 21.4% with a range from 11.2-29.9 %. The entries that recorded low deadhearts are SPV 2057, SPV 2058, SPV 2126, SPV 2129, SPV 2133 and local check.

Sweet sorghum: Across the locations and zones the overall mean DH % due to stem borer at 45 DAE was 19.5 and the range was from 12.8-25.0%. The test entries SPSSV 39, SPV 2068, SPV 2075, SPV 2076, SPH 1669, SPH 1711, SPH 1712, SPH 1713, SPV 2074, SPV 2133, SPV 2137 and local check were on par with resistant check IS 2205.

Northern region Dual purpose sorghum (DP-SB): The data on dead hearts at 45 DAE was recorded at, Hyderabad and Hisar. At Hisar the data was not significant. The range of deadhearts was 26.5 to 43.0 % averaging of 33.4%. At Hyderabad, the deadhearts range was from 9.0 to 59.1 with a mean of 23.5%. The test entries that showed promises against stem borer susceptibility are PFGS 45, ICSV 700, ICSV 705, ICSV 714,P 23, P 41, P 45, PFGS 37, PGN 30, PGN 35, PGN 39, PGN 53, PGN 61 RSE 0 RSSV 9, Satpani, and SUENT 13. They were on par with resistant check IS 2205.

National Genetic Stock Nursery (NGSN-SB): The preliminary screening of genetic stock was conducted at three locations, Hyderabad, Palem and Surat. Five hundred and twenty five lines (including susceptible checks: DJ 6514) were evaluated for susceptibility to stem borer. Every 20 rows were followed by

susceptible check and were planted 15 days before test entry planting. At Hyderabad, artificial inoculation of neonate larvae (5 larvae/ whorl) was carried out. Whereas Germplasm, were evaluated under natural conditions at Surat and Palem. About 143-197 (~174) Germplasm lines could germinate at three centers. Overall, the stem borer deadheart % at 45 DAE range was 3.25 to 88.73 % being an average of 33.41%. The data on deadheart % due to stem borer at 45 DAE are detailed in Table 12. Only four Germplasm lines have shown least damage (up to 10%) and they are EG 20, ELG 14, 1159 and 1480.

Overall conclusions: Moderate to high incidence of stem borer. The peduncle damage due stem borer is increasing in some parts of AICSIP centers.

Head bug *(Calocoris angustatus)*: Head bug population density at milk stage was recorded at Palem and Parbhani. The population colonization of head bugs was up to 17 bugs/panicle and damage rating was up to 4 in the scale of 1-9..

Midge (*Stenodiplosis sorghicola* Coq): The data on spike let damage rating (1-9) due to head bug population and damages were not recorded at any one of the centers. Spike let damage rating (1-9) due to midge was recorded at Coimbatore centre in traces. Up to 5% midge damage in Vidarbha region of Maharashtra were noticed.

Sugarcane aphids (*Rhophalosiphum maidis*): The data on aphid population did not recorded since population was inadequate at research station. Whereas, in farmers field the incidence was observed and range was from 2.5 to 17.0%.

Spider mite, ***Oligonychus indicus*** (Hirst): The damage due to mite was recorded at Surat. The population was ranged from 0.5-5.5 adults/plant and infestation rating was 4-9 in the scale of 1-9.

Validation of IPM: Some of the AICSIP centers have taken up initiatives for testing new molecules as an alternative insecticide to endosulfan. At present, in IPM trial an insecticide, Thiomethoxam (Cruiser) tested as seed treatment with or without using conventionally recommended insecticides or botanical like neem seed kernel extract and intercropped with redgram or soybean has proved to be cost effective with desirable level of pest management. However, more efforts needed to validate IPM at large acerage.

Looking ahead: There is a need to conduct large scale trials on IPM at farmer's field with new molecules and considering cost effective models for sorghum farmers.

Future work plan Kharif 2012:

1. Observations on shoot fly should be recorded when deadhearts reaches at 70 % in susceptible check.
2. Dharwad, Parbhani, Akola, Indore and Udaipur centre may be considered as hot-spot for shoot fly screening.
3. Coimbatore, Dharwad, Parbhani, Palem, Hisar and Surat centre to be considered as hot-spot for testing stem borer resistance.

Detailed report

Evaluation of sorghum experimental varieties and hybrids for resistance to key pests- kharif (rainy) season, 2011

I. Pest survey & surveillance & seasonal abundance (8 locations)

a. Tamil Nadu: The pest surveillance study was carried out in 12 farmer's field in three villages of Coimbatore districts. The research fields of Tamil Nadu Agricultural University, Coimbatore were also selected for the pest surveillance studies. The crop was sown with COS (28) and CO 30 sorghum during November and July 2011 with receipt of rainfall in these areas. The observation showed that the shoot fly damage was 0.00 to 21.80 per cent averaging 7.43% and the stem borer damage range was 0.00 to 37.26 per cent with an average of 19.40% in both the plots. Midge spikelet damage % was 0.00 to 21.09 (average 4.7%) and head bug panicle damage was rated from 2-3 in the scale of 1-9.

b. Andhra Pradesh: Nine fields (Bhojpur, Karkonda, Desi Itikyala, Gaganpally, Achampet, Vattam, Lattupally thanda, Amrabad, and Gangaram) were surveyed for pest damages in sorghum growing area in Mahaboobnagar district. Mostly sole crop (90%) and intercrop with pigeonpea was observed in Ganganpally and Achampet villages. The highest shoot fly damage was recorded in Amrabad (60%). Overall shoot fly infestation was moderate to high and damage ranged from 37.2%. The stem borer incidence has increased over last year and recorded up to 60 % with an average of 41.67%. Head panicle damage rating due to head bug was 3.44%. There was no incidence midge however the aphid damage was sporadic but at low level. There was low to moderate incidence of shoot bugs (23.33%). Two fields (Gaganapally and Amrabad) were protected either with carbofuran granules or endosulfan for the management of shoot fly and stem borer.

c. Karnataka: Moderate rains were received throughout Karnataka in general. Seven farmers field were surveyed. The damage due to shoot fly ranged from 18.8 to 55.7 % with mean of 30% dead heart. The per cent damage due to stem borer ranged from 8.1 to 18.4% with an average of 8.5%. The population of armyworm, head bug, ear head caterpillar's viz., *Helicoverpa armigera*, *Stenochroia elongella,* and midges incidences were low during the Kharif 2011 in Dharwad region. CSH 14, 16, MSH 51, AM 251, BIO 504, PRO 8384, JKSH 22, MLSH 296, and NSH 27 were found mostly grown. In Bijapur districts, five fields recorded moderate shoot fly and severe in late sown sorghum. Shoot fly was low to moderate (<15%). There was heavy attack of shoot bug in Rabi sorghum and as a result severe incidence of stripe virus was observed.

d. Maharashtra: Eight districts from Marathwada region were surveyed for pest incidences and their damage. Total 44 fields were visited tow times during cropping season. The most of sorghum was sole crop. Two districts (Osmanabad and Latur) had intercropping with pigeonpea. CSH 16, CSH 14, PVK 509 and local varieties were mainly cultivated in the area. The sowing was done during second to third week of June. There was moderate damage due to shoot fly in range of 10-28%. The infestation due to stem borer was recorded in the form of dead hearts after 60 days after emergence and it was ranged from 7 to 10 %. Moderate incidences shoot bug (<9 damage) and low grasshopper damage <15% was recorded. There was very low infestation of sugarcane aphids and medium incidences of army worms. Eleven farms in Akola, five farms in Washim and four farms in Buldhana districts were surveyed for pest infestation in Vidarbha region. Mainly, CSH 14, B296, CSH 16, SPV 669 and CSV 15 sorghum hybrids and varieties were grown. This year the shoot fly infestation was up to 40% in some of the farms due to delay in planting. The stem borer infestation was 7%. The incidences of sucking pests (shoot bug and aphids) were noticed at low level. Overall in Maharashtra, the shoot fly was 30%. Stem borer 6.08% and shoot bug was up to 10%. The grasshopper damage recorded upto 15% in some places.

e. Madhya Pradesh: Pest survey was conducted in Indore, Dewas, Dhar, Jhabua, Shajapur and Ujjain in 20 fields. There was little bit late planting of sorghum in the farmers' field. Attack of shoot fly was noticed up to 16-60 percent averaging 32.15% .The sorghum crop was attacked by stem borer up to 23 percent In the later stage of crop due to attack of stem borer, bunchy top was observed in few fields. Aphid infestation was sporadic. Among the ear head pests, *Calocoris angustatus* and *Nazara viridula* was noticed (20-45%) with population of 4-7 bugs per ear head. The panicle head worm and *Helicoverpa armigera* infested up to 5-11 % of crop.

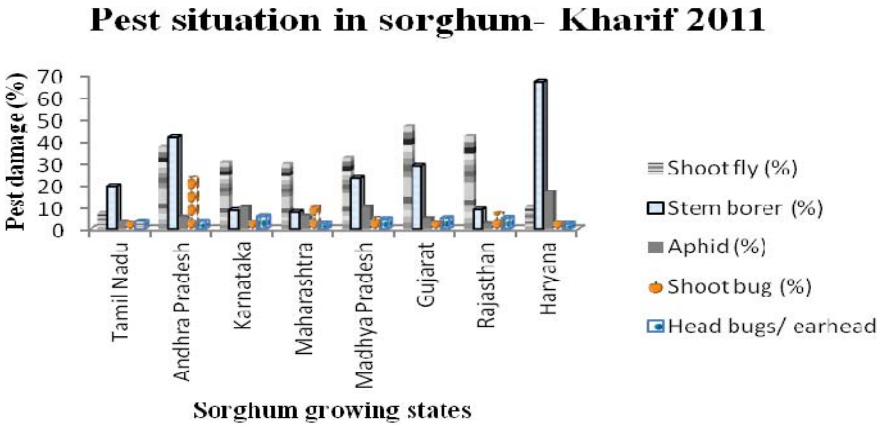
f. Gujarat: In Deesa district, there was moderate incidence of midge (*Stenodiplosis sorghicola* Coq) up to 40% in some of the farms. The moderate incidence of shoot fly (25-35 %) and low incidence of stem borer (<12%) was recorded. In Surat, there was heavy rainfall and most of the crop has been damaged due to heavy rains. The early sown crop has been vitiated in most of the farms due to heavy flood. However, in late sown crop, some of the farms have shown moderate shoot fly incidence in local cultivar (21.7 to 46.8 %). The infestation due to stem borer was low to moderate (7.9 to 28.6 %). There was low incidences of midge, head bug and shoot bug in Surat district. Mite incidence was observed in some parts of Surat districts in hybrid sorghum where severe insecticidal spray was applied.

g. Rajasthan: Survey for sorghum pest incidence was carried at six locations in two districts (Chittorgarh and Udaipur). Mostly improved varieties viz; SPV 1616, SPV 1685, and CSV 15 were planted. All the fields were grown with sole sorghum crop. No intercrop with sorghum was noticed. The incidence of shoot fly was moderate (20-30%) in timely planted sorghum. Whereas, shoot fly incidence was severe (60%) in late planted sorghum. The sugarcane stem borer sorghum borer incidence (6-8 %), head bug (5%) and shoot bug (6-7 %) was observed. There were sporadic incidences of army worm, hairy caterpillar and grasshopper and recorded up to 10%. No plant protection measures were undertaken by the farmers.

h. Haryana: Peat damage survey was undertaken in 10 farmer's field in Hisar district. The stem borer damage was prominent and recorded up to 67% dead hearts. Shoot fly damage was <10%. In dry spell, sugarcane aphid incidence was recorded up to 17%. Pyrilla damage was seen in four farmer's field and recorded 7% damage.

Summary of pest situation in sorghum growing states-kharif-2011

State	Shoot fly (%)	Stem borer (%)	Aphid (%)	Shoot bug (%)	Head bugs/ ear head	Remarks
Tamil Nadu	7.3	19.4	3.5	3.2	3.5	Midge attack up to 5%
Andhra Pradesh	37.2	41.7	5.7	23.3	3.4	Army worms with <5% damage in some parts
Karnataka	30.0	8.5	10	3.5	5.8	*H. armigera* and *Stenochroia elongella* were low (3.5 larvae /plant
Maharashtra	29.5	7.7	6.1	10	2.5	5% midge damage in Vidarbha and 10% grasshopper damage in Marathwada region
Madhya Pradesh	32.5	23	10	5.2	4.5	*Helicoverpa* up to 10%
Gujarat	46.8	28.6	5.0	3.0	5.0	Low incidences of midge
Rajasthan	42.2	8.8	2.5	7.3	5.1	Grasshoppers damage 10%
Haryana	10	67	17	3.2	2.3	Stem borer was predominant pest, Pyrilla damage up to 7%



II. Evaluation of grain and dual purpose sorghum experimental varieties/ hybrids/ parental lines for resistance to key insect pests

Four trials on grain and dual purpose sorghums viz. AHT, AVT, IHT and IVT were conducted across the zones for evaluating resistance to key pests. Total 50 test entries were subjected to evaluate for resistance against shoot fly, stem borer and midge. It is to note that Dharwad, Parbhani, Indore and Surat center planted the material at two times in view to optimize the incidence of stem borer (Early planting) and shoot fly (late planting) respectively. Fish meal was applied in late planted trials to attract shoot fly and to ensure desirable and uniform infestation. The early planted trials were conducted under natural conditions. Due care was taken to conduct AICSIP trials at hot spot locations for respective pests.

Promising entries with less susceptibility to key pests of grain and dual-purpose sorghum from different trials, Kharif- 2011 (Location: 7)

Trial	Shoot fly (<45% DH)	Stem borer (<15% DH)	Head bug (1-3 rating)
AHT (GS&DP)	Nil	SPH 1679	1635, SPH 1653, IS 18551
AVT (GS&DP)	Nil	SPV 1999, SPV 2000, SPV 2079, SPV 2083, CSV 15, CSV 17, SPV 462	SPV 2000, SPV 2079, SPV 2061, CSV 20, CSV23 and CSV 15
IHT (GS&DP)	Nil	SPH 1704	Local check, SPH 1710, SPH 1707, SPH 1702, CSH 23, SPH 1706, SPH 1704, SPH 1703, SPH 1701
IVT (GS&DP)	Nil	SPV 2115, SPV 2121, SPV 2119, SPV 2118, SPV 2122, SPV 2120, SPV 2125	SPV 2125, SPV 2120, SPV 2113, CSV 23
IVHT (MC)	Nil	SPV 2107, SPV 2108, SSG 59-3, CSH 20MF, local check	Nil
IAVT (SC)	Nil	SPV 2057, SPV 2058, SPV 2126, SPV 2129, SPV 2133	Nil
IAVHT (SS)	SPSSV 39, SPV 2075, SPV 2076, SPV 2134, SPV 2136	SPSSV 39, SPV 2068, SPV 2075, SPV 2076, SPH1669, SPH 1712, SPH 1713, SPV 2070, SPV 2134, CSH 22SS, CSV 19SS	Nil
IASFN	*Selected (< 43% DH at 28 DAE) and on par with resistant check (IS 18551): 08 BSF 06, 08RAgro 01, NRCSFR08-3-C 43 x IS 18551, NRCSFR 09-3(296 B x IS 2122) x (296 B x IS 18551), NRCSFR11-4, SUENT 9, SUENT 26, EP 57, EP 58, EC 15, POP 5, EP 96*		
DP for SF	P 55, PGN 65, PFGS 45, P 48, ICSV 705, LAWA, LDR 218, LDR 238, LOCAL -5, M-35-1, P 29, P 41, P 45, PFGS 23, PGN 39, PGN 4 RED, PGN 45, PGN 53, PGN 66, PGN 75, RSE 03, RSSV 9, SUENT 13, AKR 354		
DP for SB	PFGS 45, ICSV 700, ICSV 705, ICSV 714,P 23, P 41, P 45, PFGS 37, PGN 30, PGN 35, PGN 39, PGN 53, PGN 61 RSE 0 RSSV 9, Satpani, SUENT 13		
NGSN (GP-SF)	EJ 37, EB 2, E 56, E 72, E 75, EG 5, VKG 34/66 (up to 25% DH at 28 DAE)		
NGSN (GP-SB)	EG 20, ELG 14, 1159 and 1480 (up to 10 % DH at 45 DAE)		

Trial 1: Advance Hybrid Trial (AHT-GS & DP)

The trial AHT-GS & DP consisted of twenty four entries of which 18 hybrids, one respective local check, two resistant checks, one susceptible check and two released checks were evaluated at nine locations (Coimbatore, Palem, Udaipur in Zone I; and Dharwad, Rahuri, Parbhani, Akola, Indore, Surat in Zone II) for resistance/susceptibility to key pests.

Shoot fly (Atherigona soccata, Rond): Deadhearts caused due to shoot fly was recorded at 28 Days after emergence (DAE) at eight locations (Palem, Udaipur in Zone I; Dharwad, Rahuri, Parbhani, Akola, Indore and Surat in Zone II (Table 1.1).

The data on shoot fly could not be generated due very meager population of shoot fly at Coimbatore centre. The data of Palem on shoot fly was rejected due to low shoot fly deadhearts (< 70%) in susceptible check DJ 6514. At Udaipur, the mean damage was 46.22 % and damage ranged from 28.25 to 81.33%. The test entries SPH 1635, SPH 1647, and SPH 1668, were on par with resistant check IS 18551 which was recorded 28.25 % deadhearts (DH) due to shoot fly. Only one centre in Zone-I (Udaipur) was considered for zone mean. The results of Udaipur centre hold good for zonal average (Table 1.1).

The deadheart at Parbhani ranged from 23.3 to 75.9 % with an average of 39.8 % deadhearts. It is to note that this year shoot fly incidence at Parbhani was lower than previous year. Previous year, it was recorded an average of 60% DH. The entries SPH 1635, SPH 1647, and SPH 1648, SPH 1668, SPH 1653, SPH 1675, SPH 1676, SPH 1679, SPH 1680, SPH 1683, SPH 1684 and SPH 1685 were on par with resistant checks. At Rahuri, the range of shoot fly deadhearts was from 27.6 to 90.6 with an average of 68.0 % deadhearts. No test entry was found better than or on par with resistant check IS 18551 at Rahuri and Akola. At Akola none of the test entry was on par with the resistant checks. The mean shoot fly damage was 80.1 % at Akola and damage ranged from 37.9 – 94.3%. The incidence at Rahuri and Akola was very high 68-80 % DH. At Dharwad, the damage ranged from 42.9-97.8% with an average being 82.8 % which was the highest mean among these all centers. No entry was found on par or better than resistant check. At Indore, the mean damage was 41.2 %, range being 28.4 to 77.9%. The test entries that recorded low deadhearts are SPH 1647, SPH 1648, SPH 1655 and SPH 1674 found on par with resistant check. At Surat, the entries SPH 1680 recorded significantly lower damage 36.3% deadhearts due to shoot fly and par with resistant check IS 18551 (29.1% DH). The shoot fly mean deadheart was 45.4% with a range from 29.1 to 74.3% deadhearts (Table 1.1).

Across the locations in Zone-II, none of the entries were found on par with resistant check IS 18551. The zone range was from 31.6 to 82.4% with an average of 59.5 % deadhearts (Table 1.1).

At national level, across the locations and zones, the mean shoot fly deadheart formation was 57.6 %, range being 31.3- 82.3 %. None of the entries was significantly superior to resistant check IS 18551 or IS 2205 (Table 1.1).

Deadhearts caused due to shoot fly was recorded at 21 days after emergence (DAE) at four locations (Dharwad, Parbhani, Indore and Surat in Zone II). Across the locations in Zone –II, the damage ranged from 22.1 -61.2% DH with a trial mean of 47.3 % DH. None of the test entries were on par with resistant checks IS 18551. The IS 18551 22.1 % deadheart (Table 1.1). Deadhearts caused due to shoot fly was recorded at 14 days after emergence (DAE) at two locations (Akola and Rahuri in Zone II). Across the locations in Zone –II, the damage range was from 16.6-70.3% DH with a trial mean of 57.3 % DH. None of the test entries found on par with resistant checks IS 18551 (Table 1.1).

Morpho-physiological traits: Other morpho-physiolgical traits such as seedling vigor and leaf glossiness have been recorded only at Rahuri canter during Kharif 2011.The entries that recorded higher glossiness are SPH 1635 and local check CSV 19SS (Phule Amrita). The seedling vigor was very much prominent in SPH 1635, SPH 1648, SPH 1680, and SPH 1684. The oviposition (number of eggs per 5 plants) was recorded at Palem, Parbhani and Indore. The range of oviposition across the locations and genotypes were 1.3 to 13.0 with an average of 5.7 eggs/5 plants (Table 1.2). The least preferred test entries for oviposition were SPH 1635, SPH 1651, SPH 1676, SPH 1684 and local check and found on par with resistant check IS 18551 (2.8 eggs/5 plants). The data on seedlings (%) with shoot fly eggs was recorded at Indore and Parbhani. Over the locations, the range was 21.4-69.3 % averaging 46.0%. Only SPH 1635 was least preferred 40.2% for ovipostion and found on par with resistant check IS 18551 (21.4%) (Table 1.2).

Spotted stem borer (Chilo partellus, Swinhoe): The data on stem borer was recorded at five centers. The data on spotted stem borer infestation was assessed in terms of leaf injury plants (%) at 30 DAE, damage rating (1-9), deadhearts (%) at 45 DAE, stem tunneling (%) and peduncle damaged plants (%) at hot spot locations.

The data on percent injury plant was recorded at 30 DAE at Coimbatore, Palem, Udaipur in Zone I, and Parbhani, Dharwad, Indore, Surat in zone II. Across the locations in zone I, the data on leaf damage percentage was insignificant and ranged from 10.3-24.5% being an average of 17.2%. In zone-II, almost all entries were on par except SPH 1651, SPH 1668, SPH 1679 and DJ 6514. The range was 13.5 to 27.2% averaging 18.4%. Across the locations and genotypes at national level, the data was significant ranging from 13.7 -24.9% averaging 17.8%. Amongst test entries, SPH 1678 recorded lowest leaf damage due to stem borer (Table 1.3).

The data on injury rating (1-9) was recorded at Palem, Coimbatore and Udaipur in Zone only. The data of Coimbatore and Palem was significant. Across the locations and zones, the data on leaf damage rating was non-significant and ranged from 2.3-3.8 being an average of 2.8 in the scale of 1-9 (Table 1.3).

The data on dead hearts at 45 DAE was recorded at Coimbatore, Palem, Udaipur in Zone I, and Parbhani, Indore, Surat in zone II. In zone-I, CV % was high (>30%) except Udaipur. Over the location, the DH% due to stem borer was ranged 5.8-18.7 % being an average of 10.8%. In zone –II all entries were on par with resistant check. Across the locations in zone-II, the range recorded from 13.7 to 34.1 with an average of 19.8%. All the test entries except DJ 65141 was on par with resistant check IS 2205. Across the locations and genotypes, the data was non-significant. The overall mean DH % due to stem borer at 45 DAE was 15.3% and the range was from 11.4 to 26.4%. All test entries except SPH 1679 was on par with resistant check IS 2205 (Table 1.4).

The data on peduncle damage due to stem borer was recorded at Palem, Coimbatore in Zone-I and Surat in Zone-II. In zone-I, the range of peduncle damage 16.8- 73.5% being an average of 40.7%. Since the CV% is high (>30%), the data could not be considered. In zone-II, the peduncle damage was ranged from 13.8-52.1% with an average of 30.0%. Since the CV% is high (>30%), the data could not be considered for discussion (Table 1.4).

The peduncle tunneling (%) were recorded in Coimbatore and Indore onlyt. Across the locations and zones, peduncle tunneling (%) ranged from 13.9- 44.2% with an average of 32.5%. The least damage was recorded in SPH 1641, SPH 1647, SPH 1678, SPH 1679, SPH 1680, SPH 1680, and SPH 1684 found on par with resistant check IS 2205. The resistant check IS 2205, recorded 18.9% peduncle tunneling (Table 1.5).

Midge (Stenodiplosis sorghicola Coq): This season, no damage was seen due to midge.

Head bug (Calocoris angustatus): Head bug population density at flowering was recorded at Parbhani only. The population colonization of head bugs was moderate with a mean of (7.4 head bugs plant^{-1}). The range was from 3.7-11.3 bugs plant^{-1}. The test entries that recorded up to 7 bugs plant^{-1} are SPH 1651, SPH 1655, SPH 1668, SPH 1674, SPH 1678, SPH 1680, SPH 1683, SPH 1684, SPH 1685 CSH 16, CSH 23 and local check (PVK 809) (Table 1.4). Head bug population density at milk stage was recorded at Palem and Indore. However the data was not significant. Across the locations the data ranged from 6.3-17.5 bugs plant^{-1} averaging 12.8 bugs plant^{-1}. The lower (<10 bugs) bugs population density was observed in SPH 1655 (Table 1.5). The data on damage rating due to head bug was recorded at Palem only. However the data was not significant. The range was 2.3 to 4.3 being an average of 3.4. The entries SPH 1635, SPH 1653 and IS 18551 recorded lowest damage rating about 2.3 in the scale of 1-9 (Table 1.5).

Days to 50 % flowering: Days to 50% flowering were recorded at Parbhani, Rahuri, Indore and Surat. Across the locations and genotypes, among the entire test entries, SPH 1676 showed earliest (72 days) flowering followed by SPH 1655 and SPH 1678. Late flowering 82 days was recorded in IS 2205 and IS 18551 (Table 1.2).

Grain yield & its components: Grain yield in grams per plant was assessed at Indore and Surat. When the test entries were exposed to biotic stresses, especially insects, the grain yield plant^{-1} was recorded for all the test entries mentioned above. The mean higher grain yield (>52 g/ plant^{-1}) was recorded in SPH 1641, SPH 1647, SPH 1648, SPH 1674, SPH 1679, SPH 1680, and SPH 1683.The range was 23.0-71.6 with a mean of 45.1 g plant $^{-1}$(Table 1.5). The data on grain yield per plot was recorded at Indore centre only. However the data was not significant (Table 1.5).

Plant height: The data on plant height (cm) was recorded at Parbhani, Rahuri and Indore. Across the locations, the data on plant height was significant. The plant height ranged from 167 to 264 cm plant $^{-1}$ with an average of 194 cm plant $^{-1}$. The tallest plant height was recorded in IS 18551 (263 cm) followed by IS 2205, and local check. The dwarf height was recorded in DJ 6514 (167 cm plant $^{-1}$) flowed by CSH 23 and SPH 1675 (Table 1.3).

Plant population: The data on plant population per plot (1 row of 4 m) was recorded at Coimbatore, Palem, Parbhani, and Indore. Across the zones and locations, the data on plant population was significant. The plant stand ranged from 13.5 to 21 to plants plot $^{-1}$ with an average of 17.7 plant plot $^{-1}$ (Table 1.5).

Trial 2: Advance Varietal Trial (AVT-GS and DP)

The trial AVT-GS & DP consisted of fourteen entries of which five varieties, four released checks, two resistant checks, one susceptible check and one respective local check were evaluated at nine locations (Coimbatore, Palem, Udaipur in Zone I; and Dharwad, Rahuri, Parbhani, Akola, Indore, Surat in Zone II) for resistance/susceptibility to key pests.

Shoot fly (Atherigona soccata, Rond): Deadhearts caused due to shoot fly was recorded at 28 Days after emergence (DAE) at eight locations (Palem, Udaipur in Zone I; Dharwad, Rahuri, Parbhani, Akola, Indore and Surat in Zone II (Table 2.1).

The data on shoot fly could not be generated due very meager population of shoot fly at Coimbatore centre. The data at Palem on shoot fly was rejected due to low shoot fly deadhearts (< 70%) in susceptible check DJ 6514. At Udaipur, the mean damage was 49.2 % and damage ranged from 26.7 to 89.4%. The local check CSV 17 had lowest shoot fly damage (33.7) was on par with resistant check IS 18551 which was recorded 27.7 % deadhearts (DH) due to shoot fly (Table 1.1).

The deadheart at Parbhani ranged from 23.1 to 75.7 % with an average of 33.8 % deadhearts. It is to note that this year shoot fly incidence at Parbhani was lower than previous year. The entries SPV1999, SPV 2000, SPV 2079 and SPV 2061 were on par with resistant checks IS 18551. At Rahuri, the range of shoot fly deadhearts was from 19.4 to 83.6 with an average of 54.4 % deadhearts. No test entry except local check (CSV 19SS) was found better than or on par with resistant check IS 18551 at Rahuri. At Akola none of the test entry was on par with the resistant checks. The mean shoot fly damage was 70.7 % at Akola and damage ranged from 24.8 – 89.5%. The incidence at Rahuri and Akola was very high 54-71 % DH. At Dharwad, the damage ranged from 37.3-96.3% with an average being 75.8 % which was the highest mean among these all centers. At this center, no entry was found on par or better than resistant check. At Indore, the mean damage was 55.3 %, range being 31.9 to 74.1%. The test entry CSV 17 recorded lowest deadhearts (46.5%) after resistant checks. At Surat, the entry SPV 1919 recorded significantly lower damage 37.3% deadhearts due to shoot fly and par with resistant check IS 18551 (26.5% DH). The shoot fly mean deadheart was 45.8% with a range from 26.5 to 73.1% deadhearts (Table 2.1).

Across the locations in zone I, none of entry except CSV 15 recorded lowest damage and was on par with resistant check IS 18551. Only one centre in Zone-I (Udaipur) was considered for zone means (Table 2.1).

Across the locations in Zone-II, none of the entries were found on par with resistant check IS 18551. The zone range was from 27.2 to 80.2% with an average of 55.9 % deadhearts. None of the entries found on par with resistant check (Table 2.1).

At National level, across the locations and zones, the mean shoot fly deadheart formation was 55.0 %, range being 27.1- 81.5 %. None of the entries was significantly superior to resistant check IS 18551 (Table 2.1).

Deadhearts caused due to shoot fly was recorded at 21 days after emergence (DAE) at four locations (Dharwad, Parbhani, Indore and Surat in Zone II). Across the locations in Zone –II, the damage ranged from 17.9 -51.0% DH

with a trial mean of 39.4 % DH. None of the test entries were on par with resistant checks IS 18551. The IS 18551 recorded 17.9 % deadheart (Table 2.1).

Deadhearts caused due to shoot fly was recorded at 14 days after emergence (DAE) at two locations (Akola and Rahuri in Zone II). Across the locations in Zone –II, the damage range was from 9.6-57.5% DH with a trial mean of 41.8 % DH. None of the test entries found on par with resistant checks IS 18551 (Table 2.1).

Morpho-physiological traits: Other morpho-physiolgical traits such as seedling vigor and leaf glossiness have been recorded only at Rahuri canter during Kharif 2011.The entries that recorded higher glossiness are SPV 2079, CSV 20 and local check CSV 19SS (Phule Amrita). The high seedling vigor was recorded in SPV 2079, CSV 20 and local check CSV 19SS (Phule Amrita) (Table 2.2). The data on seedlings (%) infested with shoot fly eggs was recorded at Indore and Parbhani in Zone-II. Over all, the range 22.5-50.4 % averaging 32.7%. The data on seed ling infestation was not significant.

The oviposition (number of eggs per 5 plants) was recorded at Palem Parbhani and Indore, The range of oviposition across the locations and genotypes were 2.11-6.89 with an average of 4.37 eggs/5 plants (Table 2.2). The least preferred test entries for oviposition were SPV 1999, SPV 2000, SPV 2079, CSV 17, and SPV 462 were found on par with resistant check IS 18551 (2.11 eggs/5 plants) (Table 2.2).

Spotted stem borer (Chilo partellus, Swinhoe): The data on stem borer was recorded at six centers. The data on spotted stem borer infestation was assessed in terms of leaf injury plants (%) at 30 DAE, damage rating (1-9), deadhearts (%) at 45 DAE, stem tunneling (%) and peduncle damaged plants (%) at hot spot locations.

The data on percent injury plant was recorded at 30 DAE at Coimbatore, Palem, Udaipur in Zone I, and Parbhani, Dharwad, Surat in zone II. Across the locations in zone I, the data on leaf damage percentage was insignificant and ranged from 7.4-21.9% being an average of 15.8%. In zone-II, Almost all entries were on par with resistant check IS 2205 except DJ 6514. The range was 16.1 to 27.2% averaging 18.5%. Across the locations and genotypes at national level, the data was significant ranging from 11.7-22.3% averaging 17.2%. Amongst test entries, SPV 1999, SPV2079, SPV 2061, SPV 2083, CSV 17, SPV 462 and local check recorded lowest leaf damage due to stem borer d on par with resistant check IS 2205 (Table 2.3).

The data on injury rating (1-9) was recorded at Palem, Coimbatore and Udaipur in Zone only. Across the locations and zones, the data on leaf damage rating was non-significant and ranged from 2.44-4.56 being an average of 3.33 in the scale of 1-9 (Table 2.3).

The data on dead hearts at 45 DAE was recorded at Coimbatore, Palem, Udaipur in Zone I, and Parbhani, Surat in zone II. In zone-I, CV % was high (>30%) except in Coimbatore. Over the location, the DH% due to stem borer was ranged 4.8-19.3 % being an average of 10.1%. In zone –II all entries were on par with resistant check. Across the locations in zone-II, the range recorded from 11.18 to 33.69 with an average of 17.36%. All the test entries except DJ 6514 was on par with resistant check IS 2205. Across the locations and genotypes, the data was statistically significant. The overall mean for deadhearts % due to stem borer at 45 DAE was 12.91 % and the range was from 7.37 to 25.06%. The test entries SPV 1999, SPV 2000, SPV 2079, SPV 2083, CSV 15, CSV 17 and SPV 462 were on par with resistant check IS 2205 (Table 2.4).

The data on peduncle damage due to stem borer was recorded at Palem, Coimbatore in Zone-I and Surat in Zone-II. In zone-I, the range of peduncle damage 25.9-67.5% being an average of 39.1%. The data that recorded on stem borer peduncle damage was statically significant. The entries that showed least peduncle damage are SPV 2000, SPV 2079, SPV 2061, SPV 2083, CSV 15 and local check and are on par with resistant check IS 2205. In zone –II, the damage range was low (6.1-11.1%) with an average of 8.3%. The overall peduncle damage ranged from 19.6-

48.6% with an average of 28.8%. The data was statistically significant. The entries SPV 1999, SPV 2000, SPV 2079, SPV 2061, SPV 2083, CSV 15, SPV 462 and local check and are on par with resistant check IS 2205 (Table 2.4).

The peduncle tunneling (%) were recorded in Coimbatore and Indore only. The data on peduncle tunneling (%) recorded at Indore was low (1.8-8.9%). Hence Coimbatore was considered. The peduncle tunneling (%) ranged from 25.8- 60.0% with an average of 48.3%. The least damage was recorded in SPV 1999, CSV 15 and CSV 17 found on par with resistant check IS 2205. The resistant check IS 2205, recorded 25.8% peduncle tunneling (Table 2.5).

Midge (Stenodiplosis sorghicola Coq): There was no recordable damage due to midge at AICSIP centre.

Head bug (Calocoris angustatus): Head bug population density at flowering was recorded at Parbhani only. The population colonization of head bugs was moderate with a mean of (6.9 head bugs plant^{-1}). The range was from 4.3-10.7 bugs plant^{-1}. The test entries that recorded up to 7 bugs plant^{-1} are: SPV 1999, SPV 2000, SPV 2079, CSV20, SPV 462 and local check PVK 809 (Table 2.4). Head bug population density at milk stage was recorded at Palem and Indore. However the data was not significant at Indore. Across the locations the data ranged from 5.8-20.7 bugs plant^{-1} averaging 13.1 bugs plant^{-1}. The lowest (<10 bugs) bugs population density was observed in CSV 17 other than IS 18551 and IS 2205 (Table 2.5). The data on damage rating due to head bug was recorded at Palem only. The range was 2.0 to 4.3 being an average of 3.4. However the data was not significant at 5%. The entries that showed damage rating up to 3 are: SPV 2000, SPV 2079, SPV 2061, CSV 20, CSV23 and CSV 15. The check (IS 18551) recorded lowest damage rating (2) in the scale of 1-9 (Table 2.5).

Grain yield & its components: Grain yield in grams per plant was assessed at Indore and Surat. When the test entries were exposed to biotic stresses, especially insects, the grain yield plant^{-1} was recorded for all the test entries mentioned above. The mean higher grain yield (>40 g/ plant^{-1}) was recorded in SPCSV 15, SPV 262 and CSV 23. The range was 18.5-44.3 with a mean of 35.7 g plant $^{-1}$(Table 2.5). The data on grain yield per plot was recorded at Indore centre only. However the data was not statistically significant at 5% level (Table 2.5).

Days to 50 % flowering: Days to 50% flowering were recorded at Parbhani, Rahuri, Indore and Surat. Across the locations and genotypes, among the entire test entries, CSV 17 showed earliest (72 days) flowering followed by SPV 1999. Delayed flowering 82 days was recorded in IS 18551 (Table 2.4).

Plant height: The data on plant height (cm) was recorded at Parbhani, Rahuri and Indore. Across the locations, the data on plant height was significant. The plant height ranged from 162 to 257 cm plant $^{-1}$ with an average of 211 cm plant $^{-1}$. The highest plant height was recorded in IS 18551 (257 cm) followed by IS 2205. The shortest height was recorded in CSV 17 (162 cm) followed by DJ 6514 (165 cm plant $^{-1}$) (Table 2.3).

Plant population: The data on plant population per plot (1 row of 4 m) was recorded at Coimbatore, Parbhani, and Indore. Across the zones and locations, the data on plant population was significant. The plant stand ranged from 17 to 25 plants plot $^{-1}$ with an average of 20 plant plot $^{-1}$ (Table 2.5).

Trial 3: Initial Hybrid Trial (IHT-GS & DP) (Location: 8)

The trial IHT-GS & DP consisted of total sixteen entries of which ten hybrids, one local check, 2 resistant checks,1 susceptible check and 2 released checks were evaluated at eight locations (Palem, Udaipur in Zone I; and, Parbhani, Rahuri, Akola, Dharwad, Indore, Surat in Zone II) for resistance to key pests.

Shoot fly (Atherigona soccata, Rond): Deadhearts caused due to shoot fly was recorded at 28 Days after emergence (DAE) at eight locations (Palem, Coimbatore, Udaipur in Zone I; Dharwad, Parbhani, Akola, Indore and Surat in Zone II (Table 3.1).

The data from Palem was rejected due to low shoot fly deadhearts (< 70%) in susceptible check DJ 6514. At Udaipur, the mean damage was 49.8 % and damage ranged from 30.0 to 91.1%. The entries SPH 1704, SPH 1710

and SPH 1702 recorded lowest deadhearts amongst the test entries and were on par with resistant check. The resistant check IS 18551 recorded 30.0 % deadhearts (Table 3.1).

Across the location in Zone-I, The entries SPH 1704, SPH 1710 and SPH 1702 recorded on par with resistant check IS 18551 which recorded 30.0 % deadhearts (Table 3.1).

In Zone-II, the deadheart at Parbhani ranged from 23.9 to 81.6 % with an mean of 45.2 % deadhearts. At Parbhani the resistant check IS 18551 recorded 23.9 % deadhearts at 28 DAE.The entries SPH 1710, SPH 1702 and SPH 1708 were on par with resistant check. At Rahuri, the damage ranged from 27.1 – 95.5 % with an average being 66.5 %. Among the test entries, only local check and CSV 15 was on par with resistant check IS 18551. At Akola heavy infestation of shoot fly was recorded. The mean shoot fly damage was 78.1 % and damage ranged from 27.7 – 91.7 %. None of the test entry was on par with the resistant checks. At Dharwad, the mean damage was 85.5 %; range being 39.9 to 9.6.6 %. None of the entries were on par with resistant check IS 18551. At Indore, the shoot fly mean deadheart was 57.4 % with a range from 29.9 to 72.4 % deadhearts. Except local check none of the entries were on par with resistant check IS 18551. The local check recorded 41.1 deadhearts. At Surat the shoot fly damage ranged from 29.8 to 81.6 % the mean being 48.9 %. The entries Local check, CSH 16 and SPH 1708 were on par with resistant check IS 18551 (Table 3.1).

Across the locations in Zone-II, none of the entries were found on par with resistant check IS 18551. The deadheart range was from 29.7 to 86.5 % with an average of 63.6 %.

Across the locations and zones, the mean shoot fly deadheart formation at 28 DAE was 61.6 %, range being 29.8 – 87.2 %. None of the test entries were significantly superior to resistant check IS 18551 and IS 2205 (Table 3.1).

Deadhearts caused due to shoot fly was recorded at 21 days after emergence (DAE) at four locations (Parbhani, Dharwad, Indore and Surat in Zone II). In Zone –II, across the locations the damage ranged from 18.6 – 66.7 % DH with an average of 47.7 % DH. None of the test entries were on par with resistant check, IS 18551. The resistant check recorded 18.6% DH (Table 3.1).
Deadhearts caused due to shoot fly was also recorded at 14 days after emergence (DAE) at two locations (Rahuri and Akola in Zone II). Across the locations in Zone –II, the damage range was from 14.5 – 63.9% DH with a trial mean of 49.5 % DH. The test entries SPH 1673, SPH 1677, SPH 1680, SPH 1681, SPH 1682, SPH 1685, SPH 1687, CSH 16, CSH 23 and local check recorded deadhearts < 35%) and were on par with resistant check IS 2312 (11.2%) (Table 3.1).

Morpho-physiological traits: Morpho-physiolgical traits such as seedling vigor, leaf glossiness and seedling height have not been recorded in all the centers during Kharif 2011. However, oviposition (number of eggs per 5 plants) was recorded at Palem, Parbhani and Indore. Overall, across the locations, the data on eggs/5 plants ranged from 1.89 – 6.44 the being average of 4.76 eggs/ 5 seedlings. The test entries that recorded <4.72 eggs/5plant which was on par with resistant check IS 18551 (3.4 eggs/5 plants). The data on seedlings (%) with shoot fly eggs was recorded at Parbani and Indore. Across the locations, the seedlings infestation (%) with eggs was ranged from 15 – 48.4% with a trial mean of 39.3 %. At Rahuri data on seedling vigour and leaf glossiness were collected. The seedling vigour ranged from 1.3 – 5.0 with mean of 3.75 on scale of 1- 5. The leaf glossiness score ranged from 1.0 – 5.0 the mean being 3.88 (Table 3.2).

Spotted stem borer (Chilo partellus, Swinhoe): The data on spotted stem borer infestation was assessed in terms of leaf injury plants (%) at 30 DAE, and damage rating (1-9), deadhearts (%) at 45 DAE, stem tunneling (%) and peduncle damaged plants (%).

The data on percent leaf injury plant was recorded at 30 DAE at Coimbatore, Palem and Udaipur in Zone I, and Parbhani, Dharwad and Surat in zone II. In Zone I the damage ranged from 8.7 – 22.1 % with mean damage of 16.0 %. The entries SPH 1704, SPH 1710, SPH 1709, SPH 1707, Local check and SPH 1701 were on par with resistant

check IS 2205.The data from centers recorded with high CV in Palem in Zone-I. In Zone-II the data from Dharwad and Surat had exceptionally high CV owing to rejection. At Surat the damage was heavy the mean being 33.7 %. Across the locations and zones, range of leaf injury to plants was from 13.2 – 26.3 % with a trial mean of 17.9%. The entries SPH 1708, SPH 1704, SPH 1709, local check, SPH 1710 and SPH 1701recorded < 18.1% leaf injury and were on par with resistant check IS 2205 (Table 3.3).

The data on injury rating (1-9) was recorded at Coimbatore, Palem and Udaipur in Zone I. Across the locations, and zones, the damage2.0 – 4.11 on scale of 1-9 the mean being 2.9. The entries SPH 1703, SPH 1706 and SPH 1702 recorded higher damage. Rest of the entries were on par with resistant check IS 2205 (Table 3.3).

The data on deadhearts at 45 DAE was recorded at Coimbatore, Palem, and Udaipur in Zone I, and Parbhani, Indore and Surat in zone II. In zone-I, the DH ranged 4.0 – 20.6 % the mean being 10.6%. At all centers the CV was high (>30%). In zone –II, the damage range was 7.6 – 26.9% with an average of 13.5%. Across the locations and zones the overall mean DH % due to stem borer at 45 DAE was 12.1% and the damage ranged was from 6.0 – 23.7 %. SPH 1704 was on par with resistant check IS 2205 (Table 3.4).

The data on peduncle damage due to stem borer was recorded at Coimbatore, Palem in Zone-I and Surat in Zone-II. In zone-I, the range of peduncle damage was 8.1 – 68.7% the mean being 31.6%. In zone-II, the peduncle damage was ranged from 5.9 – 7.8% with an average of 7.8%. All entries were on par with resistant check. Across the locations and zones the peduncle damage range was 8.3 – 48.4% with trial mean of 23.6%. The entries SPH 1705, SPH 1707, SPH 1704, SPH 1705, Local check, SPH 1709, SPH 1701, SPH 1702, SPH 1708 and CSH 23 were on par with resistant check IS 2205 (Table 3.4).

The peduncle tunneling (%) were recorded in Coimbatore and Indore. Across the locations and zones, peduncle tunneling (%) ranged from 15.6 – 39.5% with an average of 27.3%. None of the entries were statistically superior to resistant check IS 2205 (Table 3.5).

Head bug (Calocoris angustatus): Head bug population density at flowering was recorded at Parbhani. The range was from 5.7 – 12.7 bugs/ panicle with an average of 8.8 head bugs/plan (Table 3.4). Head bug population density at milk stage was recorded at Palem and Indore. Across the locations, the range was from 4.5 – 15.4 with an average 8.6 bugs/panicle. The Panicle damage due to head bug was recorded in the scale of 1 to 9 at Palem. Across the locations, the panicle damage rating was from 1.7-2.7 with an average of 2.3. The test entries Local check, SPH 1710, SPH 1707, SPH 1702, CSH 23, SPH 1706, SPH 1704, SPH 1703 and SPH 1701 recorded relatively lower damage rating on par with the resistant check (2.0) (Table 3.5).

Days to 50 % flowering: Days to 50% flowering were recorded at Parbhani, Rahuri the 50% ranged from 71.9 – 82.7 days with mean being 76.7 days. Across the locations, among the entire test entries SPH 1703, SPH CSH 23, SPH 1704,Local check, SPH 1706, SPH 1707, SPH 1705 and SPH 1708 were earlier to flower (< 76.5 days)(Table 3.4).

Grain yield & its components: Grain yield in grams per plant was assessed at Indore and Surat. When the entries were exposed to desired biotic stresses, especially insects, the grain yield plant^{-1} was recorded for all the test entries mentioned above. The mean higher grain yield (>50g/ plant^{-1}) was recorded in SPH 1708, SPH 1710, SPH 1704 and SPH 1702. The range was 15.9 – 56.1 gm/plant with a mean of 44.4 g plant $^{-1}$ (Table 3.5).

Plant height (cm): Plant height (cm) was recorded at Parbhani, Rahuri and Indore. Across the locations, the plant height range was 149.08 – 238.21 cm plant $^{-1}$ with an average of 187.34 cm plant $^{-1}$. The tallest plant height was recorded in IS 18551 (238.21 cm) followed by IS 2205, local check, SPH 1705 and SPH 1701(Table 3.3).

Trial 4: Initial Varietal Trial (GS & DP) (Locations: 8)

The trial IAVHT-DP consisted of total twenty five entries of which seventeen varietie4, 2 local checks, 2 resistant checks,1 susceptible check and 4 released checks were evaluated at eight locations (Palem and Udaipur in Zone I; and Parbhani, Rahuri, Akola, Indore and Surat in Zone II) for resistance to key pests.

Shoot fly (Atherigona soccata, Rond): Deadhearts caused due to shoot fly was recorded at 28 Days after emergence (DAE) at eight locations (Palem and Udaipur in Zone I; and Parbhani, Rahuri, Akola, Indore and Surat in Zone II) (Table 4.1).

At Palem the mean damage was 38.9 % and damage ranged from 22 – 77.6%. The entries SPV 2120, CSV 20, CSV 15, SPV 2117, SPV 2110, SPV 2122, SPV 2114, SPV 2125, SPV 2123 and CSV 17 recorded lowest deadhearts and were on par with IS 18551. At Udaipur the damage ranged from 20.2 – 89.5 % DH, the mean being 44.9 % DH. The entries SPV 2117, SPV 2125 and CSV 17 were on par with resistant check IS 18551(Table 4.1).

In Zone-II, the deadhearts at Parbhani ranged from 21.9 – 76.0 % with an average of 40.5 % deadhearts. Among the test entries, SPV 2114, SPV 2122 and CSV 17 were on par with resistant check. At Rahuri, the damage range was 31.4 -83.1 % with an average of 60.6 %. The entries Local check and SPV 2111 were on par with resistant check. At Dharwad, the shoot fly mean deadhearts was 84.1% with a range from 44.0 – 100.0 % deadhearts. It is to note that none of test entries were on par with resistant checks IS 18551. At Indore the mean damage was 62.8 % with a range of 32 – 94.4 % DH. The entries Local check, SPV 2120, SPV 2117, SPV 2122, CSV 15, SPV 2124 SPV 2110 were on par with resistant check IS 18551. At Surat the mean shoot fly damage was 37.1, the range being 15.6 – 71.8 % DH. The entries SPV 2124, SPV 2119, SPV 2113, CSV 20, Local check, SPV 2111, SPV 2112 and CSV 15 were on par with resistant check IS 18551 (Table 4.1).

Across the locations in Zone-II, none of the entries were found on par with resistant check IS 18551. The deadhearts range was from 29.8 – 84.9 % DH with an average of 58.8 % (Table 4.1).

Across the locations and zones, the mean shoot fly deadheart formation at 28 DAE was 56.8 %, range being 28.4 – 85.6 %. None of the test entries were on par with resistant check, IS 18551(Table 4.1).

Deadhearts caused due to shoot fly was recorded at 21 days after emergence (DAE) at two locations (Parbhani, Dharwad, Indore and Surat in Zone II). Across the locations the damage ranged from 21.3 – 61.1 % DH with an average of 44.2 % DH. None of the test entries were on par with resistant check, IS 18551. The resistant check recorded 21.3 DH (Table 4.1).

Deadhearts caused due to shoot fly was also recorded at 14 days after emergence (DAE) at two locations (Rahuri and Akola in Zone II). Across the locations, the damage range was from 17.5 – 52.2 % DH with a trial mean of 36.5 % DH (Table 4.1).

Morpho-physiological traits: Morpho-physiolgical traits such as seedling vigor, leaf glossiness and seedling height have not been recorded in any of the centers during Kharif 2011. However, oviposition (number of eggs per 5 plants) was recorded at Palem, Parbhani and Indore. Across the locations, the data on eggs/5 plants ranged from 2.3 – 7.8 egg/5 plants, the average being 4.27 eggs/5 plants.

The data on seedlings (%) with shoot fly eggs was recorded at Parbhani and Indore. Across the locations, the seedlings infestation (%) with eggs was ranged from 21.4 – 53.6 % with a trial mean of 39.6 %. The entries SPV 2119, SPV 2124, Local check, SPV 2115, SPV 2123, SPV 2121, SPV 2125 and SPV 2110 were on par with resistant check (Table 4.2).

Spotted stem borer (Chilo partellus, Swinhoe): The data on spotted stem borer infestation was assessed in terms of leaf injury plants (%) at 30 DAE, and damage rating (1-9), deadhearts (%) at 45 DAE and peduncle damaged plants (%).

The data on percent leaf injury plant was recorded at 30 DAE at Coimbatore, Palem and Udaipur in Zone I, and Parbhani, Dharwad and Surat in zone II. In Zone-I, the data from Palem and Coimbatore centers recorded high CV (>25%) hence not considered. At Udaipur in Zone-I, the leaf injury plants due to borer ranged from 4.2 – 9.0% with a mean of 6.9 %. The data recorded across the locations in Zone-II was on par with resistant check. The damage ranged from 16.6 – 28.9 % with a mean of 21.2%. Across the locations and zones, range of leaf injury to plants was from 14.9 – 23.5 % with a trial mean of 19.1%. There was no significant difference between test entries and resistant check (IS 2205) (Table 4.3).

The data on injury rating (1-9) was recorded at Coimbatore, Udaipur in Zone I. Across the locations, the injury rating ranged from 2.2-3.3 the average being 2.85 in the scale of 1-9. There was no significant difference between test entries and resistant check (IS 2205) (Table 4.3).

The data on dead hearts at 45 DAE was recorded at Coimbatore, Palem and Udaipur in Zone I, and Parbhani, Indore and Surat in zone II. Moderate to heavy infestation of borer was observed at Palem (20.3% DH), Indore (32.2% DH), Surat (20.9% DH). In zone-I across locations, the DH% ranged 4.8 – 22.1% the mean being 10.4 %. In zone –II, the deadhearts ranged from 11.5-31.3% DH with a mean of 20.4% DH. Across the locations and zones the overall mean DH % due to stem borer at 45 DAE was 15.4 % and the range was from 8.3 – 26.7 %. The entries SPV 2115, SPV 2121, SPV 2119, SPV 2118, SPV 2122, SPV 2120 and SPV 2125 deadhearts on par with resistant check IS 2205 (8.3 %) (Table 4.4).

The data on peduncle damage due to stem borer was recorded at Coimbatore, Palem, in Zone-I and Surat in Zone-II. In zone-I, the range of peduncle damage was 17.6 – 61.3 % with mean of 35.4%. All the entries that recorded peduncle damage on par with resistant check IS 2205 (17.5%). At Surat, the peduncle damage was ranged from 5.7 – 13.4% with an average of 4.7%. Across the locations and zones the peduncle damage range was 14.4 – 45.3 % with trial mean of 26.5%. The entries SPV 2115, SPV 2119, CSV 15, SPV 2116, SPV 2123, SPV 2121, SPV 2125, SPV 2124, SPV 2120 were on par with resistant check, IS 2205. The resistant check recorded 17.5 % (Table 4.4).

Head bug (Calocoris angustatus): Head bug population density at milk stage was recorded at Palem and Indore. Across the locations, the population ranged from 40.1 – 11.6 bugs / panicle with mean of 7.7 bugs/panicle. All the entries were on par with resistant check IS 18551 (Table 4.5).

The Panicle damage due to head bug was recorded in the scale of 1 to 9 at Palem and Coimbatore. Across the locations, the panicle damage rating was from 1.7-14.0 with an average of 2.5. All entries were on par with resistant check and the data was non-significant. The entries recorded (1.7) damage rating are SPV 2125, SPV 2120, SPV 2113 and CSV 23 (Table 4.5).

Days to 50 % flowering: Days to 50% flowering were recorded at Parbhani, Rahuri, Indore and Surat. At Parbhani, the range was from 56 – 72.3 days with a mean of 67.5 days. At Rahuri, the range was 65.7-79.0 with a mean of 70.6 days. Across the locations, the 50 % flowering ranged from 77.9 – 82.3 days. The entry SPV 2120 was earliest to flower across locations (Table 4.4).

Plant height (cm): Plant height (cm) was recorded at Parbhani, Rahuri and Indore. The plant height range was 140-260 cm plant $^{-1}$ with an average of 216.0 cm plant $^{-1}$. The maximum plant height was recorded in IS 18551, IS 2205, SPV 2118, SPV 2115 and Local check (Table 4.3).

III. Evaluation of forage sorghum experimental varieties/hybrids/ parental lines for resistance to insect pests

Two forage sorghum trials viz. IAVHT (Multi-cut) and IAVT (Single-cut), were conducted across the zones for evaluating resistance to key pests at six locations (Surat, Udaipur, Hisar in zone-I, Dharwad, Coimbatore, Akola in Zone-II). Total twenty nine test entries were subjected to evaluate for resistance against shoot fly and stem borer. Fish meal was applied in planted trials to attract shoot fly and to ensure desirable infestation. Due care was taken to conduct AICSIP trials at hot spot locations for respective pests.

Trial 5: Initial Varietal and Hybrid Trial (IVHT-Forage-Multi-cut) (Locations: 6)

The trial IVHT-MC consisted of total fifteen entries of which 6 hybrids, 2 varieties, 1 local check, 2 resistant checks, 1 susceptible check and 3 released checks were evaluated at six locations (Udaipur, Surat, Hisar in Zone I; and Coimbatore Dharwad, Akola, in Zone II) for resistance to key pests mainly shoot fly and stem borer.

Shoot fly (Atherigona soccata, Rond): Deadhearts caused due to shoot fly was recorded at 28 Days after emergence (DAE) at four locations (Udaipur, Surat in Zone-I and Akola, Dharwad in Zone-II).

In Zone-I, the shoot fly damage range was from 22.5 to 80.7% with mean of 39.5 %. The lowest deadhearts recorded in SPH 1698 and CSV 20MF were on par with resistant check IS 2312 (22.5% DH). In Zone-II, the shoot fly was from 39.9 to 94.7 % with an average of 81.4%. None of the entries were on par with resistant checks. The resistant check IS 18551 recorded 39.9% (Table 5.1).

Across the locations and genotypes, the shoot fly damage at 28 DAE was from 31.2 to 87.5% being an average of 60.5%. Although the data was statistically significant at 5% level, but no entry was on par with resistant check IS 18551 that recorded 31.2% DH at 28 DAE (Table 5.1).

Deadhearts caused due shoot fly was also recorded at 21 DAE at Surat and Dharwad. But no entry was performed better or on par with resistant check IS 18551. The shoot fly dead hearts at 14 DAE was recorded at Akola. The damage was from 23.3 to 72.4 being an average of 47.3%. Only SSG 59-3 was performed on par with resistant check IS 18551 (Table 5.1).

Morpho-physiological traits: Antixenosis for oviposition on seedlings was not evaluated at any centre.

Spotted stem borer (Chilo partellus, Swinhoe): The data on spotted stem borer infestation was assessed in terms of leaf injury plants (%) at 30 DAE, and damage rating (1-9), deadhearts (%) at 45 DAE, stem tunneling (%) and peduncle damaged plants (%).

The data on peduncle damage due to stem borer was recorded at Coimbatore and Surat. At Surat, the peduncle damage was low and ranged from 6.2-12.3 averaging 8.3%. At Coimbatore, the peduncle damage was very high and ranged from 23.5-87.0 % being an average of 59.8%. Across the location and zone, the peduncle damage was moderate and ranged from 6.2-44.4% being an average of 30.4%. The data was non-significant at 5 % level and all test entries were on par with resistant check IS 2205 (Table 5.1).

The data on peduncle tunneling (%) due to stem borer were recorded in Coimbatore only. At Coimbatore, the peduncle tunneling ranged from 37.583.8 % with being mean of 57.1%. None of the test entries were statistically significant at 5% level (Table 5.1).

The data on percent leaf injury plant was recorded at 30 DAE at Udaipur, Surat in zone-I and Coimbatore, Dharwad in zone-II, The data recorded at Udaipur had low range of leaf unjury (5.0-7.7%) averaging 6.5%.with slightly high CV (26.2%). Whereas in Surat, the % of leaf injury was from 26.2-50.1% averaging 34.4%. Across the locations in zone-I, the range of leaf injury to plants was from 16.1-27.5% with a mean of 20.4%. The data was on par with resistant check. In Zone-II, both at Dharwad and Surat the data on plant injury was on par with resistant check. Overall, the

lowest leaf damage (<15 was recorded in SPV SPH 1696 and SPH 59-3 and CSV21F recorded < 19% leaf injury and on par with resistant check IS 2205 (Table 5.2).

The data on injury rating (1-9) was recorded at Udaipur and Coimbatore. At Coimbatore, the leaf damage rating was from 2.0- 5.0 with a mean of 3.1. At Udaipur, the damage rating range was from 2.03.0 with a mean of 2.5. Across the locations and zones, the data on leaf damage rating was not significant and ranged from2.2- 3.7 being an average of 2.8 in the scale of 1-9. All teat entries were on par with resistant check except DJ 6514 (Table 5.2).

The data on dead hearts at 45 DAE was recorded at Hisar, Udaipur, Surat in Zone-I and Coimbatore in Zone-II. Across the locations in zone I, the deadheart per cent range was from 12.8 to 21.9 being an average of 17.2%. All test entries were on par with IS 2205 except SPH 1697, SPH 1699, CSH24MF and DJ 6514. At Coimbatore, the data was very scanty and non significant at 5% level. The range was from 4.3-17.1 % with a mean of 27.5%. Across the locations and zones, the mean deadheart was 16.2% with a range from12.8-20.9 %. The entries that recorded <15% damage are SPV 2107, SPV 2108, SSG 59-3, CSH 20MF and local check (Table 5.2).

Midge (Stenodiplosis sorghicola Coq) and Head bug (Calocoris angustatus): The data on spike let damage rating (1-9) due to midge and the data on head bug population and damages were not recorded at any one of the centers mentioned above.

Days to 50 % flowering: The data on days to 50% flowering were recorded at Coimbatore only and the range was from 37.5-83.8 days with an average of 57.1 days. The entries that recorded longest days (>80 days) to flower are SPV 2107 and SPH 1695. The entries that flowered before 40 days are: IS 2205and SPH 1697. However the data on flowering was not significant at 5% level (5.3).

Grain yield & its components: Grain yield in grams per plant was assessed at Surat. When the test entries were exposed to biotic stresses, especially insects, the grain yield plant^{-1} was recorded for all the test entries mentioned above. The mean of grain yield plant^{-1} was ranged from 15.7-56.0 g averaging 26.8 g. The data on highest grain yield per plant was recorded in local check GJ 42 (56.0g Plant $^{-1}$) (Table 5.3).

Plant population: The data on plant population per plot (1 row of 4 m) was recorded at Coimbatore only. The data on plant population was not significant. The plant stand range was from 1 to 31 plants plot $^{-1}$ with an average of 16 plant plot $^{-1}$ (Table 5.3).

Trial 6: Initial Advanced Varietal Trial (IAVT-Forage-Single cut) (Locations: 6)

The trial IAVT-SC consisted of total seventeen entries of which eleven varieties, 1 local check, 2 resistant checks, 1 susceptible check and 2 released checks were evaluated at six locations (Udaipur, Hisar and Surat in Zone I; and Dharwad, Coimbatore in Zone II) for resistance to key pests mainly shoot fly and stem borer.

Shoot fly (Atherigona soccata, Rond): Deadhearts caused due to shoot fly was recorded at 28 Days after emergence (DAE) at four locations (Udaipur, Surat in Zone-I and Akola, Dharwad in Zone-II).

In Zone-I, the shoot fly damage range was from 23.8 to 80.3% with mean of 40.0 %. The lowest deadhearts recorded in SPV 2057 and CSV 21MF were on par with resistant check IS 2312 (23.8% DH). In Zone-II, the shoot fly damage range was from 38.6 to 97.5 % with an average of 78.7%. None of the entries were on par with resistant checks. The resistant check IS 18551 recorded 38.6% (Table 6.1).

Across the locations and genotypes, the shoot fly damage at 28 DAE was from 31.2 to 88.9% being an average of 59.3%. Although the data was statistically significant at 5% level, only one entry (SPV 2057) was on par with resistant check IS 18551 at 28 DAE (Table 6.1).

Deadhearts caused due shoot fly was also recorded at 21 DAE at Surat and Dharwad. The data on deadhearts was significant at 5% level. The shoot fly deadheart at 21 DAE range was from 25.1 to 68.8% being an average of 49.0%. The entries SPV 2127 and SPV 2130 recorded lowest deadhearts and were on par with resistant check IS 18551.

The shoot fly deadhearts at 14 DAE was recorded at Akola. The damage was from 13.7 to 54.9 being an average of 37.2%. The data was significant at 5% level. The entries SPV 2057, SPV 2133 and HC 308 were performed better and on par with resistant check IS 18551. The resistant check IS 18551 recorded 13.7 deadhearts due to shoot fly at 14 DAE (Table 6.1).

Morpho-physiological traits: Antixenosis for oviposition on seedlings was not evaluated at any centre.

Spotted stem borer (Chilo partellus, Swinhoe): The data on spotted stem borer infestation was assessed in terms of leaf injury plants (%) at 30 DAE, and damage rating (1-9), deadhearts (%) at 45 DAE, stem tunneling (%) and peduncle damaged plants (%).

The data on dead hearts at 45 DAE was recorded at Hisar, Udaipur, Surat in Zone-I and Coimbatore in Zone-II. Across the locations in zone I, the deadheart per cent range was from 15.7 to 33.0 being an average of 25.9%. All test entries were on par with IS 2205 except SPH 1697, SPH 1699, CSH24MF and DJ 6514. In zone-II, at Coimbatore, the data was very scanty and non significant at 5% level. The range was from 2.13-23.3 % with a mean of 12.5%. Across the locations and zones, overall the mean deadheart was 21.4% with a range from11.2-29.9 %. The entries that recorded low deadhearts are SPV 2057, SPV 2058, SPV 2126, SPV 2129, SPV 2133 and local check (Table 6.1).

The data on peduncle tunneling (%) due to stem borer were recorded in Coimbatore at was statistically not significant at 5% level. The peduncle tunneling ranged from 24.2-44.8 % with a mean of 37.1%. The entries SPV 2056, SPV 2057, SPV 2058, SPV 2128, SPV 2129, SPV 2131 and HC 308 were on par with IS 2205 (Table 6.1).

The data on percent leaf injury plant was recorded at 30 DAE at Udaipur, Surat in zone-I and Coimbatore, Dharwad in zone-II, The data recorded at Udaipur had low range of leaf injury (4.0-7.7%) averaging 5.5%.with high CV (32.3%). Whereas in Surat, the % of leaf injury was from 20.7-440.6% averaging 32.9%. Across the locations in zone-I, the range of leaf injury to plants was from 13.1-24.3% with a mean of 19.2%. The data was not significant at 5% level. In Zone-II, at Coimbatore, the damage range was 105-38.9 with an average of 26.1. In Dharwad, the data on plant injury was on par with resistant check. Across the locations in zone-II, the range of leaf injury % was 10.1-24.6 averaging of 18.2%. Overall, at national level almost all entries were on par with resistant check IS 2205. The entries had lowest leaf injury % (<20%) are: SPV 2056, SPV 2057, SPV 2058, SPV 2126, SPV 2127, SPV 2129, SPV 2132, SPV 2133, HC 308, and CSV21F and local check (Table 6.2).

The data on injury rating (1-9) was recorded at Udaipur and Coimbatore. At Coimbatore, the leaf damage rating was from 2.0- 4.7 with a mean of 3.6. At Udaipur, the damage rating range was from 2.0-3.0 with a mean of 2.5. Across the locations and zones, the data on leaf damage rating was not significant and damage rating ranged from2.2- 3.5 being an average of 2.9 in the scale of 1-9. All teat entries were on par with resistant check except DJ 6514 (Table 6.2).

The data on peduncle damage due to stem borer was recorded at Coimbatore and Surat. At Surat, the peduncle damage was low and ranged from 5.3-12.5 averaging 8.0%. At Coimbatore, the peduncle damage was very high and ranged from 11.4-50.9 % being an average of 32.1%. Across the location and zone, the peduncle damage was moderate and ranged from 9.1-29.9% being an average of 18.7%. The data was non-significant at 5 % level and all test entries were on par with resistant check IS 2205 (Table 6.2).

Midge (Stenodiplosis sorghicola Coq) and Head bug (Calocoris angustatus): The data on spike let damage rating (1-9) due to midge and the data on head bug population and damages were not recorded at any one of the centers mentioned above.

Days to 50 % flowering: The data on days to 50% flowering were recorded at Surat only and the range was from 79.7-86.0 days with an average of 84.2 days. The entries that recorded longest days (>80 days) are: SPV 2056, SPV 2057, SPV 2058, SPV 2126, SPV 2127, SPV 2129, SPV 2133 and local check (Table 6.2).

Grain yield & its components: Grain yield in grams per plant was assessed at Surat. When the test entries were exposed to biotic stresses, especially insects, the grain yield plant^{-1} was recorded for all the test entries mentioned above. The mean of grain yield plant^{-1} was ranged from 28.3-49.7 g averaging 37.8 g. The data on highest grain yield per plant was recorded in SPV 2131 i.e 49.7g Plant $^{-1}$ (Table 6.2).

Plant population: The data on plant population per plot (1 row of 4 m) was recorded at Surat only. The data on plant population was not significant. The plant stand range was from 6.3 to 25.7 plants plot $^{-1}$ with an average of 14.4 plant plot $^{-1}$ (Table 6.3).

IV. Evaluation of SWEET sorghum experimental varieties/ hybrids/parental lines for resistance to insect pests

Trial 7: Initial Advanced Varietal and Hybrid Trial (IAVHT-SS) (Locations: 6)

One sweet sorghum trial (IAVHT) was conducted across the zones for evaluating resistance to key pests. Total twenty five entries were subjected to evaluate for resistance against shoot fly, stem borer and other pests at six locations (Coimbatore, Udaipur and Hisar in zone-I and Rahuri, Akola, Dharwad and Surat in zone-II). The trial IAVHT-SS consisted of total twenty five entries of which 5 hybrids13 varieties, 1 local check, 2 resistant checks, 2 susceptible checks and 2 released checks were evaluated at six locations. Fish meal was applied in trials to attract shoot fly for desirable infestation levels. Due care was taken to conduct trials at hot spot locations for respective pests.

Shoot fly (Atherigona soccata, Rond): Deadhearts caused due to shoot fly was recorded at 28 Days after emergence (DAE) at six locations (Coimbatore, Udaipur and Hisar in zone-I and Rahuri, Akola, Dharwad and Surat in zone-II) (Table 7.1).

In zone-I, the data at Udaipur recorded on shoot fly damage deadhearts at 28 DAE. The mean damage was 51.2% and ranged from 27.6-88.1%. The entries SPSSV 39, SPV 2075, SPV 2076, SPV 2134 and SPV 2136 recorded lowest deadhearts and were on par with resistant check IS 18551.

In zone-II, the mean damage was 60.8% and damage range was from 31.4-85.9%. Only two entries viz; SPV 2068 and SPV 2136 recorded lowest deadhearts and were on par with resistant check IS 18551. The resistant check IS 18551 recorded 31.4 % deadhearts (Table 7.1).

Across the zones and genotypes the entry SPV 2136 recorded lowest deadhearts % and was on par with resistant check. The damage range was 30.7-86.3 with an average of 58.9% at 28 DAE. The data was significant at 5% level (Table 7.1).

Deadhearts caused due to shoot fly was recorded at 21 DAE at two locations (Dharwad and Surat in Zone II). Across the locations the damage ranged from 26.5-71.4 % with an average of 51.6 % deadhearts. The test entries SPSSV 39, SPV 2068, SPV 2069, SPH 1713, SPV 2134, SPV 2136 and CSV 19SS were on par with resistant check, IS 2312. The resistant check recorded 26.5% deadhearts (Table 7.1).

Deadhearts caused due to shoot fly was also recorded at 14 days after emergence (DAE) at two locations (Rahuri and Akola in Zone II). Across the locations, the deadhearts range was from 13.6-62.1% DH with a trial mean of 38.1 %. The test entries SPV 2136 and local check were on par with resistant check IS 2312. The resistant check recorded 13.6% deadheart (Table 7.1).

Morpho-physiological traits: Other morpho-physiolgical traits such as seedling vigor and leaf glossiness have been recorded only at Rahuri canter during Kharif 2011.The entries that recorded higher glossiness are SPV 2076, SPV 2068, SPV 2136 and local check CSV 19SS (Phule Amrita). The high seedling vigor was recorded in SPV 2068, SPV 2136 and local check (< 3) (Table 7.3).

Spotted stem borer (Chilo partellus, Swinhoe): The data on spotted stem borer infestation was assessed in terms of leaf injury plants (%) at 30 DAE, and damage rating (1-9), deadhearts (%) at 45 DAE, stem tunneling (%) and peduncle damaged plants (%).

The data on peduncle damage due to stem borer was recorded at Coimbatore and Surat. At Coimbatore, the CV% was high (>30%). In zone-II, in Surat, the peduncle damage was low (5.4-11.3% with an average of 9.1%. The data is non-significant. Overall the range of peduncle damage was from 7.6-39.8% with a mean of 21.7%. All entries were on par with resistant check except SPV 2070 (Table 7.1).

The peduncle tunneling (%) were recorded in Coimbatore. At Coimbatore, peduncle tunneling (%) ranged from 15.8-56.3 %with an average of 38.9 %. All the entries were on par with resistant check and the data was non-significant (Table 7.1).

The data on per cent leaf injury plant was recorded at 30 DAE at Coimbatore, Udaipur in Zone I, and Surat, Rahuri and Dharwad in zone II. The data at Coimbatore recorded high CV (>30%). Across the locations, in zone-I, the data ranged from 8.0-54.0% with a mean of 23.8%. All entries were on par with resistant check except SPV 2133 and SPV 2135. All entries in Zone-II were significantly on par with resistant check. The range was from 18.9-32.5 averaging 24.5%. Across the locations and zones, the data on per cent leaf injury due to stem borer was not significant. The leaf damage range was from16.0 to 37.0% with a trial mean of 24.4% (Table 7.2).

The data on injury rating (1-9) was recorded at Coimbatore, Udaipur in Zone I, and Surat in zone II. Across the locations in Zone-I, the data on leaf damage rating was not significant and ranged from 1.7-3.1 being an average of 2.39 in the scale of 1-9. There were no significant differences between the genotypes (Table 7.2).

Across the locations and zones, the leaf damage rating ranged from 21.7 to 3.1 with a mean of 2.4. All the test entries were on par with resistant check (Table 7.2).

The data on dead hearts at 45 DAE was recorded at, Coimbatore, Udaipur, Hisar in Zone I, and only Surat in zone II. In zone-I, the data of Coimbatore had high CV (>30%) and was non-significant. At Udaipur, the deadhearts range was very low (1.7-7.3) with a mean of 4.7%. Most of the test entries were on par with resistant check except few. At Hisar, the deadheart range was from 24.0-44.0 % with a mean of 33.5%. The data on deadheart at 45 DAE was non-significant. In Zone-I across the locations, the deadhearts % ranged from 12.9-24.7% with mean of 19.1%. No significant differences were recorded between the test entries. The data could not be analyzed due to scanty data in Coimbatore. In zone-II, at Surat, the data on deadhearts % ranged from 12.6-28.3% with a mean of 20.5%. The test entries SPSSV 39, SPV 2068, SPV 2075, SPV 2076, SPH1669, SPH 1712, SPH 1713, SPV 2070, SPV 2134, CSH 22SS, and CSV 19SS were on par with resistant check IS 2205.

Across the locations and zones the overall mean DH % due to stem borer at 45 DAE was 19.5 and the range was from 12.8-25.0%. The test entries SPSSV 39, SPV 2068, SPV 2075, SPV 2076, SPH1669, SPH 1711, SPH 1712, SPH 1713, SPV 2074, SPV 2133, SPV 2137 and local check were on par with resistant check IS 2205 (Table 7.2).

Midge (Stenodiplosis sorghicola Coq) and Head bug (Calocoris angustatus): The data on spike let damage rating (1-9) due to midge and the data on head bug population and damages were not recorded at any one of the centers mentioned above.

Days to 50 % flowering: The data on days to 50% flowering were recorded only at Rahuri and Surat. Across the locations and genotypes, the range was from 82-92 days with an average of 87 days. All entries recorded >81 days. DJ 6514 recorded longest days to flower 92 days. However, the data on flowering were not significant (Table 7.3).

Grain yield & its components: Grain yield in grams per plant was assessed at Surat. When the test entries were exposed to biotic stresses, especially insects, the grain yield plant^{-1} was recorded for all the test entries mentioned above. The mean of grain yield plant^{-1} was ranged from 20.7-58.7 g averaging 34.4 g. The test entries SPH 1669, SPH 1670, SPH 1711 and SPH 1713 recorded >45 g plant yield and were on par with released check CSH 22SS (Table 7.3).

Plant population: The data on plant population per plot (1 row of 4 m) was recorded at Coimbatore only. The plant stand range was from 1.0 to 14.3 plants plot $^{-1}$ with an average of 6.9 plant plot $^{-1}$. The data on plant population was not significant (Table 7.3).

Plant height (cm): Plant height (cm) was recorded at Rahuri. The plant height range was 177.0- 328.0 cm plant $^{-1}$ with an average of 284.9 cm plant $^{-1}$. The maximum plant height was recorded in SPV 2133 (328.0 cm) and the least was in SPV 2070 (177 cm) (Table 7.3).

V. Screening of initial and advance material for specific pest resistant

Shoot fly (Atherigona soccata, Rond)

Trial 8: Testing of initial and advance lines for shoot fly resistant (IASFN)

The trial was conducted at three locations, Hyderabad, Akola and Udaipur. Forty entries (Nine from national crossing block, DSR, Nine from breeding crossing program, DSR, six from AICSIP, Udaipur, thirteen from Germplasm Unit, DSR, one susceptible check DJ 6514, one resistant check IS 18551, and one local check CSV 15) were evaluated for resistance to shoot fly.

Shoot fly deadhearts: The data on shoot fly deadhearts at 28 DAE was recorded at Hyderabad, Akola and Udaipur. All the data recorded on shoot fly deadhearts were statically significant at 5% level. At Akola, the mean damage was 59.6 and range was from 32.8-95.3%. The test entry NRCSFR 08-3- C 43 x IS 18551, NRCSFR11-4, SUENT 9, EP 57, POP 52 and EP 96 recorded lowest deadhearts and was on par with resistant check. At Udaipur, the range was 20.9-70.2% being an average of 33.3%. The test entries recorded relatively low deadhearts and were on par with resistant checks. The entries are 08 RSF 01, NRCSFR 09-3 (296 B x IS 2122) X (296B x IS 18551) C 43 x IS 18551, NRCSFR11-1,SUENT 9, EP 57, EC 15, EC 19 and GGUB 54. At Hyderabad, the deadhearts range was 25.4-77.0 averaging 44.8%. The entries showed low deadhearts are SUENT 9, SUENT 26, NRCSFR 09-3 (296 B x IS 2122) X (296B x IS 18551) C 43 x IS 18551 and POP 52 and were on par with resistant check.

Across the locations, the damage range was from 28.5-80.8% with mean of 45.9%. The entries 08 BSF 06, 08RAgro 01, NRCSFR08-3-C 43 x IS 18551, NRCSFR 09-3(296 B x IS 2122) x (296 B x IS 18551), NRCSFR11-4, SUENT 9, SUENT 26, EP 57, EP 58, EC 15, POP 52 and EP 96 were on par with resistant check IS 18551. The resistant check recorded 28.5 % DH at 28 DAE (Table 8.1).

Morpho-physiological traits: Morpho-physiolgical traits such as seedling vigor, leaf glossiness and seedling height have been recorded in one of the centers during Kharif 2011. The data on seedling infestation (%) with eggs was recorded only at Hyderabad and was significant at 5% level. The range was from 13.0-59.6 with a mean of 24.8%. Most of the test entries were on par with resistant checks IS 18551. The entries 08 BSF 01, NRCSFR 08-3- C 43 x IS 18551, NRCSFR11-1, SUENT 26, SUENT 9, EP 117, POP 52, GGUB 54 and local check CSV 15 showed relatively lower oviposition and were on par with resistant check (Table 8.1).

Chlorophyll content: The data on chlorophyll content (SPAD meter reading) was recorded was not significant. The range was 43.97-54.67 being an average of 49.43. Highest chlorophyll content was recorded in local check CSV 15 (54.67) and the lowest was 43.97 (Table 8.1)

Overall resistant rating: The data on overall rating on resistance was recorded at Hyderabad. Resistant rating scale was used 1-9. The entries that showed good resistant rating (<4) are 08BSF 01, NRCSFR11-3 & E 38 (Table 8.1)

Days to 50 % flowering: Days to 50% flowering were recorded at Akola and Hyderabad. Overall across the location the range was 66-93 days with a mean of 82 days. Most of the entries were recorded flowering 66 days and above (Table 8.1).

Plant height (cm): Plant height (cm) was recorded at Hyderabad. The plant height range was 74-275 cm with a mean of 182 cm plant $^{-1}$. The maximum plant height was recorded in IS 2312 (275 cm) and the least was in 08BSF 02 (74 cm) (Table 8.1).

Trial 9: Testing of northern region dual purpose sorghum for shoot fly resistant (DP-SF)
The trial was conducted at three locations, Hyderabad, Indore and Udaipur. Sixty eight entries (including susceptible, resistant and local checks) were evaluated for resistance mainly to shoot fly.

Shoot fly dead hearts: The data on shoot fly deadhearts at 28 DAE was recorded at Hyderabad, Indore and Udaipur. All the data recorded on shoot fly deadhearts were statically significant at 5% level. At Indore, the mean damage was 39.3 and range was from 24.6-76.3%. Twenty five test entries recorded lowest deadhearts (<36%) and was on par with resistant check. At Udaipur, the deadheart range was 25.9-77.9% being an average of 41.5%. The test entries about 32 recorded relatively low deadhearts (<42%) and were on par with resistant checks. At Hyderabad, the deadhearts range was 26.1-73.5 % being an average of 37.3%. Thirty four test entries showed low deadhearts (<37%) and were on par with resistant check.

Across the locations, the damage range was from 27.1-73.9% with mean of 40.0%. The entries P 55, PGN 65, PFGS 45, P 48, ICSV 705, LAWA, LDR 218, LDR 238, LOCAL -5, M-35-1, P 29, P 41, P 45, PFGS 23, PGN 39, PGN 4 RED, PGN 45, PGN 53, PGN 66, PGN 75, RSE 03, RSSV 9, SUENT 13, and AKR 354 were on par with resistant check IS 2312. The resistant check recorded 27.1 % DH at 28 DAE (Table 9.1).

Morpho-physiological traits: Morpho-physiolgical traits such as seedling vigor, leaf glossiness and plant height have been recorded in one at Hyderabad during Kharif 2011. The data on seedling infestation (%) with eggs was recorded only at two centers i.e. Hyderabad and Indore. The data at Indore was not significant at 5% level and CV was >30%. The range was from 1.75-11.70 with a mean of 5.27 %. The data at Hyderabad was significant at 5% level. About fifteen test entries were on par with resistant checks IS 2312. The entry PGN 57, P 48, PFGS 37 and PGN 61 recorded < 15% oviposition and were on par with resistant check IS 2312. The resistant check recorded 12.3 % seedling affected with eggs. Across the locations and genotypes, the data was non-significant. However, the entry PGN 57, PFGS 47, PGN 30, PGN 56, PGN 66 and RSE 03 recorded up to 10% seedling affected with shoot fly eggs (Table 9.1).

Glossiness and seedling vigor: The data on glossiness and vigor (1-9 rating) was recorded at Hyderabad. The entries recorded high vigor (up to 2 rating) is PGN 45 and PGN 66. The high glossiness rating (up to 2) was recorded in P 48, ICSV 705, Lawa, LDR 218, PFGS 23, PFGS 47, PFGS 48, PFGS 94, PGN 45 and PGN 66 (Table 9.1).
Overall resistant rating: The data on overall rating on resistance was recorded at Hyderabad and was significant at % level. The range was from 2.0-9.0 averaging of 5.7. The entries that showed high resistant (up to 3 rating) rating are ICSV 700, ICSV 705, ICSV 714, LDR 238, LOCAL 5, P 41, PUGL 9, RSE 03, RSSV 9, SATPANI, SPV 1388, SPV 1388 x Lawa, SSV 84, SUENT 13, 27B, 296B, and AKR 354 (Table 9.1).

Chlorophyll content: The data on chlorophyll content (SPAD meter reading) was recorded at Hyderabad and found insignificant at 5% level. The range was 46.3-58.4 being an average of 51.9. Highest chlorophyll content was recorded in local check PGN 45 (58.4) and the lowest was in PFGS 45 (46.2) (Table 9.2)

Days to 50 % flowering: Days to 50% flowering were recorded at Indore and Hyderabad. Overall across the location the range was 68-88 days with a mean of 77 days. Most of the entries were recorded flowering 68 days and above (Table 9.2).

Plant height (cm): Plant height (cm) was recorded at Indore and Hyderabad. The plant height range was 183-315 cm with a mean of 256 cm plant $^{-1}$. The maximum plant height was recorded in IS 18551(315 cm) and the least was in is ICSV 705 (183 cm) (Table 9.2).

Plant population: The data on plant population per plot (1 row of 4 m) was recorded at Indore and Hyderabad. Overall the plant stand range was from 18 to 33 plants plot -1 with an average of 27 plant plot -1. However the data on plant population was not significant (Table 9.2).

Grain yield & its components: Grain yield in grams per plant was assessed at Indore. When the test entries were exposed to biotic stresses, especially insects, the grain yield plant^{-1} was recorded for all the test entries mentioned above. The mean of grain yield plant^{-1} was ranged from 1.1-18.1 g averaging 6.2 g. However, the data was not significant (Table 9.2).

Trial 10: Screening of germplasm lines for shoot fly susceptibility (NGSN-SF)

The preliminary screening of genetic stock was conducted at three locations, Hyderabad, Indore and Udaipur. Five hundred and twenty five lines (including susceptible checks) were evaluated for susceptibility to shoot fly. Every 20 rows were followed by susceptible check and were planted 15 days before test entry planting. The fish meal was placed as an attractant to ensure optimum level of shoot fly population. About 125 Germplasm lines could germinate at three centers. Overall, the shoot fly deadheart range was 19.1 to 100 % being an average of 51.5%. The data on deadheart % due to shoot fly at 28 DAE are given in Table 10. The lines EJ 37, EB 2, E 56, E 72, E 75, EG 5 and VKG 34/66 showed least damage due to shoot fly (up to 25%).

Less susceptible line to shoot fly (up to 25 % DH) at 28 DAE

	Hyderabad	Indore	Udaipur	Mean
Germplasm screened	500	500	500	500
Not germinated	124	120	120	122
SF DH (%) -Mean	59.7	61.9	37.3	53.0
SF DH (%) -Min	16.7	12.5	10.6	13.3
SF DH (%) -Max	100	100	79.5	93.2
DJ 6514 (Sus check)	74.4	81.8	67.9	74.7
IS 18551 (Res check)	32.2	29.5	35.2	32.3
Less susceptible lines (<25%)	EJ 37, EB 2, E 56, E 72, E 75, EG 5, VKG 34/66			

Spotted stem borer (Chilo partellus, Swinhoe*)*

Trial 11: Testing of northern region dual purpose sorghum for stem borer resistant (DP-SB)

The trial was conducted at three locations, Hyderabad, Coimbatore and Hisar. Sixty eight entries (including susceptible, resistant and local checks) were evaluated for resistance mainly to stem borer.

The data on spotted stem borer infestation was assessed in terms of leaf injury plants (%) at 30 DAE, and damage rating (1-9), deadhearts (%) at 45 DAE, stem tunneling (%) and peduncle damaged plants (%). The peduncle tunneling (%) were recorded in Hyderabad. The peduncle tunneling (%) ranged from 7.9-36.7 % with an average of 20.6 %. Almost all entries were on par with resistant check. The promising entries are: ICSV 705, P 23, PFGS 37, PGN 30, PGN 35 and PGN 53 (Table 11).

The data on injury rating (1-9) was recorded at Hyderabad. The data on leaf damage rating was significant and ranged from 3.5-8.0 being an average of 5.7 in the scale of 1-9. The promising entries are: PGN 35, RSSV 9 and SUENT 13. The resistant check IS 2205, recorded 4 injury rating (Table 11). The data on dead hearts at 45 DAE was recorded at, Hyderabad and Hisar. At Hisar the data was not significant. The range of deadhearts was 26.5 to 43.0 % averaging of 33.4%. At Hyderabad, the deadhearts range was from 9.0 to 59.1 with a mean of 23.5%. The test entries that showed promises against stem borer susceptibility are PFGS 45, ICSV 700, ICSV 705, ICSV 714,P 23, P 41, P 45, PFGS 37, PGN 30, PGN 35, PGN 39, PGN 53, PGN 61 RSE 0 RSSV 9, Satpani, and SUENT 13. They were on par with resistant check IS 2205 (Table 11). Across the locations and zones the overall mean DH % due to stem borer at 45 DAE and the range was from 20.0 to 44.1 % with an average of 28.4.0%. The data was not significant. Only PGN 61 recorded lowest deadhearts (20.0%) at 45 DAE (Table 11).

Plant population: The data on plant population per plot (2 rows of 4 m) was recorded at Hyderabad. Overall the plant stand range was from 19-37- plants plot -1 with an average of 28 plant plot -1. However the data on plant population was not significant (Table 11).

Trial 12: Screening of germplasm lines for stem borer susceptibility (NGSN-SB)

The preliminary screening of genetic stock was conducted at three locations, Hyderabad, Palem and Surat. Five hundred and twenty five lines (including susceptible checks: DJ 6514) were evaluated for susceptibility to stem borer. Every 20 rows were followed by susceptible check and were planted 15 days before test entry planting. At Hyderabad, artificial inoculation of neonate larvae (5 larvae/ whorl) was carried out. Whereas Germplasm, were evaluated under natural conditions at Surat and Palem. About 143-197 (~174) Germplasm lines could germinate at three centers. Overall, the stem borer deadheart % at 45 DAE range was 3.25 to 88.73 % being an average of 33.41%. The data on deadheart % due to stem borer at 45 DAE are detailed in Table 12. Only four Germplasm lines have shown least damage (up to 10%) and they are EG 20, ELG 14, 1159 and 1480.

Less susceptible line to stem borer (up to 10% DH) at 45 DAE

	Hyderabad	Palem	Surat	Mean
Germplasm screened	500	500	500	500
Not germinated	143	197	191	143
SF DH (%) -Mean	41.00	25.82	26.72	33.41
SF DH (%) -Min	3.20	3.30	4.09	3.25
SF DH (%) -Max	100.00	100.00	66.20	88.73
DJ 6514 (Sus check)	58.84	46.05	39.38	48.09
IS 18551 (Res check)	9.40	6.42	17.28	11.03
Less susceptible lines (up to 10%)	EG 20, ELG 14, 1159, 1480			

VI. Study of external factor's influences on expression of protective mechanisms in shoot fly

Origin of the proposal: Introgression of desirable genes using wide hybridization is an important method to create variation which is central for crop improvement. Though Sorghum genus is having over 35 species efforts on interspecific hybridization was limited due to various incompatibility factors, chiefly the pollen pistil interactions. Lack of high resistance among germplasm for the shoot pests on one hand, identification of genes for germination / inhibition to alien pollen (Iap allel) among *Sorghum bicolor* by Price et.al., on the other has renewed interest in interspecific crosses. In this direction the morpho-anatomical characters among the wild relatives with known high level of resistance viz., *S. versicolor, S. purpureocereceum, S. matarankense* to shoot pests (shoot fly and stem borer) were studied in detail. During these investigations, it was discovered that some wild relatives were having long leaf hairs all over the lamina which could form defense against the shoot pest infestation as have been reported in other plants. Looking forward to finding similar hairs in the cultivated *S. bicolour* is the origin of this study. Looking to this, a trial have been laid to observe the nature of uniformity of the novel mechanisms of shoot fly resistance in the parental lines, released varieties and resistance sources of sorghum.

Objective: To study the nature of uniformity of the novel mechanisms of shoot fly resistance in the parental lines, released varieties and resistance sources of sorghum.

Methodology: The above entries planted at the locations till 28 days under natural, unprotected conditions. Samples of 15 seedlings were collected from each entry for observations on development of resistant phenotypic, anatomical and cytological characters. AICSIP Entomologists from respective centers have assisted to execute this trial.

Treatments:
1. Entries: 12 = (4 varieties, 4 parental lines, 4 resistant lines)
2. Dates of sowing: 4 = (10 June; 15 July; 7 October; 8 November)

Plot size: 2 Sq meters nursery area for each entry to raise 15-20 Nos. seedlings till 30 days.
Locations (4): Dharwad, Parbhani, Rahuri, Hyderabad

Dates	K1	K2	R1	R2	
Locations	Dharwad	Parbhani	Rahuri	Hyderabad	
Parental Lines	296 B	27B	C43	CS3541	
Varieties	CSV 15	SPV 462	DJ6514	Swarna	
Resistant sources	IS 18551	IS 2312	IS 2205	IS 2122	POP 52

K1 Normal Kharif date; K2 Late Kharif, R1 Normal Rabi date; R2 Late Rabi

Summary of the findings: The leaf hairs in *S. bicolour* entries observed are single celled, long, highly transparent and distributed mainly on the upper lamina (adaxial) side as in the case of the wild species. They differ from the wild counterparts only in the length of the hair; while in the wild relatives they are longer, in S. bicolour they are relatively shorter. In some wild species they are present all over the lamina and petiole as well as stem interodes and nodes and very prominent in appearance. The leaf hairs are unidirectional and face the leaf tip. The unidirectional arrangement combined with high transparent nature makes them visible only when the light is directed tangentially from the bottom of the leaf towards the tip. The fact that they are totally invisible / escape observation in other lighting conditions is probably the reason for their occurrence not reported earlier.

The leaf hairs are restricted towards the upper portions on the adaxial side from third to fifth / seventh leaves in the case of entries with very low susceptibility viz., IS 18551, IS 2312 and low susceptibility SPV 462, CS 3541 and C 43 in the parents / varieties of *S. bicolor*. In general their number vary between 300 – 800 per leaf in the least susceptible entries depending on the season. Whereas, in the case of highly susceptible genotypes, the leaf hair number is significantly small (<50), or totally absent in some seasons. In general the low leaf hair scores were recorded during early kahrif (June first week) and progressively increasing thereafter. In some entries (IS18551, CS3541) about 20% plants have leaf hairs on the lower side also but their number is comparatively limited (<25). The leaf hairs present on the upper portions of the leaf are pointed upwards and contributed to filling the whorl in the case of resistant wild species and less susceptible genotypes as observed in the cross sections. During the early developmental stages they may help to prevent the adult insects from landing and impede their movement which needs to be closely followed. In some of the less susceptible genotypes variation in the number of the hairs was observed among individual plants. This may be due to the variation arising from the different parentage and due to absence of selection pressure to select for their uniformity. Occurrence of these novel anatomical characters extensively only in the less susceptible genotypes need to be explored further to identify their usability.

VII. Validation of IPM modules for shoot pests

Application of endosulfan has been banned for crop protection. There is a need to evaluate new molecules at AICSIP centers. Some of the AICSIP centers have taken up initiatives for testing new molecules. At present, in IPM trial an insecticide, Thiomethoxam (Cruiser) tested as seed treatment with or without using conventionally recommended insecticides or botanical like neem seed kernel extract and intercropped with redgram or soybean has proved to be cost effective with desirable level of pest management.

Annexure I: DSR-AICSIP Publications in Entomology-2011

S. No.	Name of the Author	Title of the paper. Volume no. issue No.	Type
1	Bhagwat, VR, Shaym Prasad, G, A. Kalaisekar, Subbarayudu B., Upadhyaya SN, Daware, D G Rote R G and Rajaram V (2011)	Evaluation of some local sorghum checks for shoot fly, *Atherigona soccata* Rondani and Stem borer, *Chilo partellus* Swinhoe resistance. *Annals of Arid Zone (Accepted: M/s No: ADZ/2010/25 dated 21-10-10)*	Journal
2	Anita, V.Sable and Shekharappa, 2011	Ecofriendly management of sorghum shoot fly, *Atherigona soccata* Rondani through seed treatment, Journal of Eco- friendly Agriculture 6(1): 37-40	Journal
3	Bhagwat VR, Srinivas Babu K, G Shyam Prasad, Daware, DG, Subbarayudu B, Prabhakar and Patil JV 2011	Companioning Sorghum with Safflower for the Management of Shoot fly and Aphids in Post-rainy Season, abstract submitted in the *"8th International Safflower Conference"* to be held during 19-23 January, 2012 at DOR, Hyderabad	Abstract

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Annexure-II: AICSIP Entomology trials and nurseries conducted Kharif 2011

Trial No	Trials	Ent	Rep	Plot size	Number of trials to be conducted at each AICSIP centres												Total
					Coi	*Dha*	*Pal*	*Par*	*Rah*	*Ako*	*Ind*	*Sur*	*Uda*	*Hyd*	*His*	*Dee*	
I. Evalation of reglar/on-going AICSIP trials for key pest resistance																	
1 (a & b)	AHT (GS & DP)	24	3	1r x 4 m	1	2	2	2	1	1	2	2	1				14
2 (a & b)	AVT (GS & DP)	14	3	1r x 4 m	1	2	2	2	1	1	2	2	1				14
3 (a & b)	IHT (GS & DP)	16	3	1r x 4 m	1	2	2	2	1	1	2	2	1				14
4 (a & b)	IVT (GS & DP)	25	3	1r x 4 m	1	2	2	2	1	1	2	2	1				14
5 (a &b)	IAVHT (MC)	15	3	1r x 4 m	1	2				1		2	1		1		8
6 (a & b)	IAVHT (SC)	17	3	1r x 4 m	1	2				1		2	1		1		8
7 (a & b)	IAVHT (SS)	25	3	1r x 4 m	1	2			1	1		2	1		1		9
II. Interdisciplinary program on basic & strategic research for multi-pest resistance/agronomic characters																	
8	NGSN-GP-SB	525	1	1r x 4 m			1					1		1			3
9	DP-SB	68	2	1r x 4 m	1									1	1		3
10	NGSN-GP-SF	525	1	1r x 4 m							1		1	1			3
11	DP-SF	68	2	1r x 4 m							1		1	1			3
12	Midge (F3)	30	1	10 r x 4 m		1						1				1	3
13	F6 > F7 (SB)	80	1	4 r 4 m			1							1	1		3
14	IASFN	40	3	1r x 4 m						1			1	1			3
15	F5 > F6 (F5-SF)	22	1	4 r x 4 m										1			1
16	F3 pops (F3-SF)	12	1	4 r x 4 m										1			1
17	BEAT	16	3 x 2	4 r x 4 m										1			1
18	WA lines -SF	14	3	1r x 4 m										1			1
19	Forage -SF	24	3	1 r x 4 m										1			1
20	Forage -SB	24	3	2 r x 4 m										1			1
21	AVHT-GS-late Kh	18	3	1 r x 4 m	1 kovil												1
22	Novel mechnisms	12	2 sow	50 SL		1		1	1					1			4
III. On-farm evaluation of IPM module/public sector trials																	
23	On-Farm IPM	3		1 acre		1	1	1					1				4
IV. Pest surveillance, seasonal abundance & population dynamics of sporadic & unusual pest outbreaks																	
24	Pest survey			Farmers field	Mandotary for all centres, use proforma												
			Total trials		8	17	11	10	6	8	10	16	11	13	5	1	116

Note: Two plantings of each common trials as a & b should be followed, where there is incidence of shoot fly and stem borer.

Annexure-III: Entomology trials data-Compliance report Kharif 2011

S No	Centre	No of trials supplied	First Sowing	Second sowing	Date of data received					
					Shoot fly	Stem borer	Midge	Shoot bug	Head bug	Aphids
1	Coimbatore	8	11-Jul	NS	5 Oct	5-Oct	5 Oct		5-Oct	NR
2	Palem	11	11 Jul	16 Jul	05-Jan	05-Jan	NR	NR	05-Jan	NR
3	Parbhani	10	11-Jul	16Jul	29-Sep	22-Nov	NR	NR	22-Nov	NR
4	Akola	8	6-Aug	NS	20 Oct	NR	NR	NR	NR	NR
5	Dharwad	17	27-Jun	20-Jul	11-Sep	11-Sep	NR	NR	NR	NR
6	Indore	10	26-Jun	11-Jul	31-Aug	17-Sep	NR	NR	24-Nov	NR
7	Surat	16	7-Jul	30-Jul	30 Sep	22-Nov	NR	NR	NR	NR
8	Rahuri	6	28-Jun	NS	19-Oct	NR	NR	NR	NR	19 Oct
9	Udaipur	11	28-Jul	NS	19-Sep	20-Nov	NR	NR	NR	NR
10	Hisar	5	11 Jul	NS	15 Jan	15-Jan	NR	NR	NR	NR

NS = Not Sown; NR = Not Received

Annexure-IV: Hot spots locations for key pests

Centre (Hot spot)	Key peats
Parbhani	Shoot fly
Udaipur	Shoot fly
Coimbatore	Head bug , Stem borer
Dharwad	Shoot fly,
Palem	Shoot fly
Surat	Shoot fly, Stem borer
Indore	Shoot fly
Akola	Shoot fly
Bijapur	Shoot fly, Aphid, Stem borer
Rahuri	Shoot fly, Aphid
Hyderabad	Shoot fly, Stem Borer

Annexure-V: The list of Sorghum Entomologists in AICSIP- Kh 2011

No	Name	Brief address	email
1	Dr. P Anandhi, Sorghum Entomologist	SRS, TNAU, Coimbatore SRS, TNAU, Kovilpatti	kovilpatti@sorghum.res.in coimbatore@sorghum.res.in
2	Dr Kavitha, Sorghum Entomologist	RARS, Palem	kaviangrau@yahoo.com
3	Dr Shekharappa Sorghum Entomologist	ARS, UAS, Dharwad	shekhar1993@yahoo.com
4	Dr AP Biradar Principal Entomologist	RARS, UAS, Bijapur	bijapur@sorghum.res.in, apbiradar123@rediffmail.com
5	Dr DB Pawar, Sorghum Entomologist	Sorghum Improvement Project, MPKV, Rahuri	rahuri@sorhum.res.in
6	Dr DG Daware, Sorghum Entomologist	MAU, Parbhani	parbhani@sorghum.res.in
7	Dr. SP Mehtre Sorghum Biotechnologist	MAU, Parbhani	spmehtre@yahoo.co.in
8	Dr Sameer Kale, Sorghum Entomologist	Sorghum Res. Scheme (AICSIP) DPDKV, Akola	akola@sorghum.res.in
9	Dr RK Choudhary Sorghum Entomologist	JNKKV, College of Agriculture, Indore	umsax@rediffmail.com, indore@sorghum.res.in
10	Dr KA, Patel Sorghum Entomologist	MSRS, NAU, Surat	surat@sorghum.res.in
11	Dr T Hussain, Entomologist	MPAUT, Udiapur	udiapur@sorghum.res.in
12	Dr HC Sharma, Principal Entomologist	ICRISAT, Patancheru	h.sharma@cgiar.org
13	Dr G Shyam Prasad	DSR, Hyderabad	shyam@sorghum.res.in
14	Dr VR Bhagwat, Convener	DSR, Hyderabad	bhagwat@sorghum.res.in