

# AICSIP ENTOMOLOGY PROGRAM – KHARIF- 2013-14

## *Evaluation of sorghum experimental varieties, hybrids and parental materials for resistance to key pests*

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## Executive summary

### Introduction

Total 126 genotypes were received from AICSIP centers in the form eight trials (AHT-GS, AVT-GS, IHT-GS, IVT-GS, IAVHT-MC, AVT-SC, IVHT-SC and IAVHT-SS) were evaluated for pests for resistance/tolerance at the respective hot-spot locations mainly at Coimbatore, Palem, Rahuri, Indore, Surat, and Hisar for stem borer and Dharwad, Palem, Akola, Parbhani, Indore, Surat and Udaipur for shoot fly. Five checks (IS 18551, IS 2205, ICSV 745, DJ 6514, and Swarna) were incorporated from Entomology. Other than regular trials, pest specific trials two on shoot fly and one on stem borer with a total of 164 lines developed through team efforts of entomology-breeding-germplasm were evaluated. A set of 12 lines were also evaluated for pest and disease resistance through entomology-pathology collaborative efforts. All the entries were evaluated under artificial condition by placing fish meal for shoot fly attractions. Whereas, the lines for stem borer were evaluated under natural conditions except at Hyderabad.

### Pest scenario in sorghum

This year there was relatively moderate rainfall than normal rain fall in all most all centers. Due to longer dry spell, the pest incidence was moderate to higher particularly, shoot fly at Akola, Parbhani, Dharwad, Indore, Udaipur; and stem borer at Dharwad, Hisar, Surat and Coimbatore. The peduncle damage and tunneling damage recorded increase in percent particularly in Coimbatore. Very low incidence of midge (<2%) was recorded in Surat, and Deesa. Among the ear head pests, *Calocoris angustatus* and panicle head worms and *Nezara* infested sorghum up to 5%. The mite incidence seems to be increasing particularly in south Gujarat. *Pyrilla* showed its existence in northern part particularly in Haryana (<5 %).

### Shoot fly (*Atherigona soccata*, Rond)

*General trend:* The shoot fly incidence was moderate to high (40-100%) at Dharwad, Parbhani, Akola, Indore, Surat and Udaipur.

*Grain sorghum:* In AHT and AVT, the DH% range was 38-82%. Only one test entry SPH 1703 recorded low deadheart and was on par with resistant check IS 18551. In IHT and IVT trial, the range was 49-88%. The test entry SPH 1748 recorded low deadhearts % due to shoot fly at peak stage.

*Forage (multi cut):* The shoot fly damage at peak stage in IVHT-MC was from 41 to 84% being an average of 61%. No entry was on par with resistant check IS 18551.

*Forage (single-cut):* In AVT & IVHT, the shoot fly damage at peak stage was from 34-85%. The promising entries SPV 2186, SPV 2258 and SPV 2191 recorded low DH and are on par with resistant check.

*Sweet sorghum:* In IVAHT-SS, the damage range was 41-85 % with an average of 63% at peak stage. None of the test entries were on par with resistant check.

*Selected entries from AICSIP trials (AICSP-SPN):* The entries selected from AICSIP during Kharif 2012 had a range of 39-81% with average of 60%. The entries SPV 2196, SPV 2203, SPV 2204 and RSSV 9 recorded low deadhearts due to shoot fly.

*Northern based dual purpose sorghum: (Elite DP-SF):* Overall, the damage range was from 29-79% with mean of 40%. The entries LDR 238, PGN 39, RSSV 9, SUENT 13, EC 15, ICSB 411, ICSV 705, ICSV 93046, IS 2123 and IS 2146 were on par with resistant check IS 2312. The resistant check recorded 29 % deadhearts at peak stage.

*Shoot pest resistance nursery (DSR-SPRN):* Across the locations, the damage range was from 39-86% with mean of 59%. The entries M 35-1 x ICSV 714)-3-1-1, (M 35-1 x IS 2312-1)-3-2-2, and (ICSV 700 x ICSV 705)-1-1-1 were on par with resistant check IS 18551. The resistant check recorded 39 % DH at peak stage.

*Forage local check (Forage-LC-SF):* Across the three locations, the range was 43-89% averaging 62%. The entries CO (FS)-29, CSV 21F, Ramkel, Katakhatav, RSSV 9, Rampur local and Sangoli Hundi recorded low damage.

*Pest and Disease resistance (PDRN):* The average was 55% ranging from 40 to 80%. The entries NRCS-FR09-3, RSSV 9 and SUENT 13 recorded low shoot fly and were on par with resistant check.

### Spotted stem borer (*Chilo partellus*, Swinhoe)

*General trend:* The stem borer incidence was moderate to high. The highest damage was noticed at Indore (60 %). At Coimbatore, Surat, and Hisar, moderate population was observed. The stem tunneling at Coimbatore is increasing.

*Grain sorghum:* In AHT-GS and AVT-GS, the DH% range was 13-26%. The entries SPH 1736, SPH 1731, SPH 1736, CSH 30, LC SPV 2114, CSV 20, SPV 2174, SPV 2178 and SPV 2182 recorded low deadhearts % at 45 DAE. In IHT (GS) and IVT (GS), the DH range was 5-23 %. The test entries SPV 2191 and SPV 2258 recorded low deadhearts % at 45 DAE.

**Forage sorghum:** The stem borer damage at 45 DAE in IAVHT-multi-cut trial was from 6 to 21% being an average of 10%. The test entries that recorded lower deadhearts due to stem borer are SPH 1695, SPH 1698, SPH 1752, SPH 1753 and SPV 2242. In AVT and IVT, the shoot fly damage at 45 DAE was from 8-37 %. The entries SPV 2191 and ICSV 745, SPV 2258 recorded low DH and are on par with IS 2205.

**Sweet sorghum:** In IVAHT-SS, the damage range was 9-21 % with an average of 16% at 45 DAE. Only the entry CSV 19SS recorded low deadheart % and was on par with resistant check.

**Selected entries from AICSIP trials (AICSP-SPN):** The entries selected from AICSIP during Kharif 2012 had a range of 4-11% with average of 7%. The entries SPV 2114, SPV 2122, SPV 2057, SPV 2127, SPV 2130, SPV 2131, SPV 2132, SPV 2186, SPV 2197 and SPV 2198 recorded low deadhearts due to stem borer.

**Northern based dual purpose sorghum: (Elite DP-SF):** Overall, the damage range was from 13-41% with mean of 22%. The entries P 23, P 45, PGN 30, PGN 39, PGN 61, RSV 9, Satpani, PGN 111, EC 15, EP 96, ICSV 93046 and IS 2123 were on par with resistant check IS 2205. The resistant check recorded 13.6 % deadhearts at 45 DAE.

**Shoot pest resistance nursery (DSR-SPRN):** Across the locations, the damage range was from 9-28% with mean of 15%. The progenies (PGN 35 x PGN 30)-3-2,(EC 15 x ICSV 714)-2-1-2, (ICSV 700 x IS 2205-1)-3-1-2 and (ICSV 700 x ICSV 705)-1-1-1 were on par with resistant check IS 2205. The resistant check recorded 9.8 % DH at 45 DAE.

#### **Head bug (*Calocoris angustatus*)**

Damage rating (1-9) due to ear head bugs was recorded at Palem and Indore. Total 26 test entries from all trials were recorded <3 damage rating.

#### **Shoot bug (*Peregrinus maidis*)**

No shoot bug damage was recorded at any of these centers.

#### **Spider mite *Oligonychus indicus* (Hirst)**

The damage rating (1-9) was recorded at Surat only. The damage was noticed up to 8 rating. Total 30 test entries from all trials recorded < 3 damage rating.

#### **Midge (*Stenodiplosis sorghicola* Coq)**

No recordable incidence was noticed particularly from Coimbatore, Dharwad and Surat.

#### **Sugarcane aphids (*Rhopalosiphum maidis*)**

The data on aphid population did not recorded since population was inadequate at research station.

#### **Validation of IPM**

Some of the AICSIP centers have taken up initiatives for testing newer molecules of insecticides as an alternative to endosulfan. At present, in IPM trial an insecticide, Thiomethoxam (Cruiser) as seed treatment proved effective against shoot fly. While in another preliminary trial, the combined application of carbaryl @ 3g/l+ carbendazim @ 1g/l showed promise for managing ear head damage and ergot disease.

#### **Overall conclusions**

1. Dharwad, Parbhani, Rahuri, Akola, Indore, Surat and Udaipur centre may be considered for hot spot for shoot fly screening.
2. Hisar, Coimbatore, Surat and Indore may be considered hot spot for stem borer.
3. A data on selected and few parameters for targeted pest may be required to study mechanism of resistance and correlations for traits.
4. The effective management of head bug damage and ergot can be done with the combined application of carbaryl @ 3g/l+ carbendazim @ 1g/l and also helped in increasing grain yield.

#### **Future work plan- Kharif 2014**

1. Observations on shoot fly should be recorded when deadhearts reaches at 70 % in susceptible check. If it is more than 70% insecticidal spray may be applied to protect promising entries.
2. Dharwad, Parbhani, Akola, Indore, Surat 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.
4. Need to find out the causes of outbreak of stem borer incidence at Indore and its management.
5. Transformation method may be adopted during statistical analysis for reducing CV%. It needs further discussion. The data may be considered for interpretation if CV% is <25%.

## Detailed report

### I. Pest survey & surveillance & seasonal abundance (eight locations)

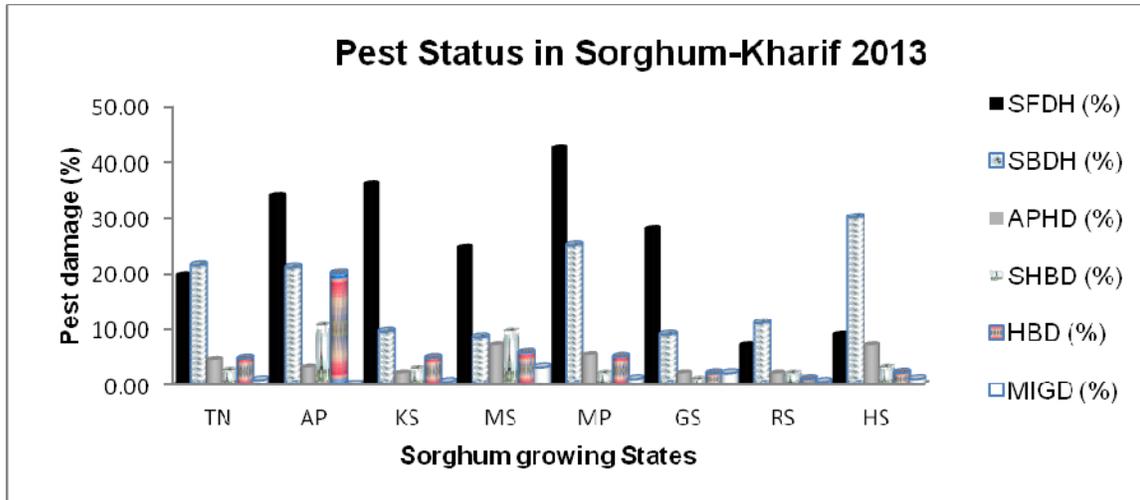
- a. **Tamil Nadu:** The pest surveillance study was carried out in 8 farmer's field in three villages of Coimbatore district. The crop was sown mostly with COS (28) sorghum during 18-25 October 2013, on the receipt of rainfall under late Kharif region. The observation showed that the shoot fly damage was 5.0-38.4 per cent averaging 19.7 % and the stem borer damage range was 0.00 to 31.26 per cent with an average of 21.40%. Midge spikelet damage % was 0.00 to 4.2 with an average of 0.78 % and head bug panicle damage was rated from 2-3 in the scale of 1-9 (up to 4.7%) and shoot bug damage (2.5%) was damage rating was up to 3. Aphid damage was recorded up to 4.5% in some of the fields.
- b. **Andhra Pradesh:** Ten fields (Lattupally Thandas, Khanapur, Gangaram, Bolgalpally, Nallavelly, Bhoypapur, Manganoor, Thimmajipet, and Palem) in Meahboobnagar district were surveyed. Local sorghum mostly yellow jowar was sown by most of the farmers. Very few fields (about 20%) had intercropping with red gram. The shoot fly damage ranges from 20 to 45% averaging 34% deadhearts; the stem borer damage was ranged from 10 to 30 % averaging 21 % at 45 DAE. Panicle damage rating due to head bug (1-9 scale) was 2.28 that count about 20% panicle damage. The shoot bug damage was ranged from 5 to 15% with 10.56%. Aphid infestation was minimum level 3%. No plant protection measures were undertaken by the famers. Low incidence of head worms and grasshoppers (2%) were observed.
- c. **Karnataka:** Moderate to heavy rains were received throughout Karnataka in general. Fifteen farmers field were surveyed. The shoot fly incidence ranged from 24.5 to 65.0% with an average of 36%. The mean incidence of stem borer was 9.5% ranging from 4.5 to 12%. The incidence of midge was quite low (0.5%). The natural enemies like *coccinellids* were found 0.50 per plant. The extent of parasitization to stem borer by *Cotesia flavipes* was to an extent of 6.5%. The other pests like armyworm, head bug, grasshopper and ear head caterpillar's viz., *Helicoverpa armigera*, *Stenochroia elongella* were negligible during the cropping season. C SH 14, 16, MSH 51, AM 251, BIO 504, PRO 8384, JKSH 22, MLSH 296, and NSH 27 were found mostly grown. During Kharif, in Bijapur districts, the Kharif sorghum was less grown, nine fields recorded moderate shoot fly and severe in late sown sorghum. Shoot fly was low to moderate (13.5-29.8%).
- d. **Maharashtra:** Twenty six fields from two districts (Parbhani and Hingoli) in Marathwada region were surveyed for pest incidences and their damages during cropping season. Mostly local sorghum was planted as a sole crop. No intercropping was seen in these two districts. The sowing was done during second to third week of June. There was moderate damage due to shoot fly in range of 12-34% averaging 26.5% deadhearts. The infestation due to stem borer was recorded in the form of deadhearts after 60 days after emergence and it was ranged from 5 to 15 % with an average of 9.1%. Moderate incidences shoot bug 1- 4 no/whorl (<2 damage rating, 5%) and low grasshopper damage <5% was recorded. There was low infestation of sugarcane aphids (4-7 aphids/leaf, 9%) and a medium incidence of army worms was noticed. In Vidarbha region, the sowing of sorghum crop was completed during third week of July. The overall crop condition was good. The incidence of sorghum shoot fly was moderate ranging from 11.8 to 30.6% deadhearts averaging 18.7% on the timely sown crop. The deadhearts due to stem borer was moderate and recorded 5.7 to 11.9% averaging 8.5%. The infestation of the midge was also noticed during the crop season on the cob but it was negligible (0.45 midge/ear head, 6.5%). The aphid predator like lady bird beetle was also observed on the sorghum in the range of 0.38 to 2.72 LBB/meter row length as the incidence of aphids noticed ranging from 11 to 26 aphids / leaf / sq.cm. Total 21 farmers' field were visited (9 in Akola, 7 in Washim and 5 in Buldhana districts) for pest damage survey in Vidarbha region. Mostly, CSH 9, CSH 14, B-296, CSH 16, SPV 669 and CSV 15 sorghum varieties and hybrids were grown. Considering two region, overall in Maharashtra, the shoot fly was 24 %, stem borer 8.5% and shoot bug was up to 9%, aphid incidence was up to 7% and head bug damage was up to 5%. The midge was at low level (3%). The grasshopper damage recorded up to 5% in some places.
- e. **Madhya Pradesh:** Pest survey was carried out in 30 fields from Indore, Dhar, Jhabua, Badwani, Khargone, Dewas, ,Shajapur and Ujjain districts. Mostly, the sowings were done with the onset of monsoon. Incidence of shoot fly was high 30-80% averaging 42.5%. The sorghum crop was attacked by stem borer up to 25-50

percent. Aphid infestation was observed in traces (<5%). Among the ear head pests, *Calcoris angustatus* and *Nazara viridula* was noticed, but the damage was below economic injury level i.e. 5-7 % with the population of 3-9 bugs per ear head . The panicle head worm and earhead pest damage infested up to 5-10 percent crop plants.

- f. **Gujarat:** In Deesa district, there was moderate incidence of midge (*Stenodiplosis sorghicola* Coq) up to 20% in some of the farms. The incidence of shoot fly ranges from 32-41 % and moderate incidence of stem borer (10-27%) was recorded. In Surat, The incidence of shoot fly was ranged from 19.00 to 46.78 per cent in GJ-42. The incidence of stem borer deadhearts percentage ranged from 12.19 to 29.43 and leaf injury range from 26.48 to 47.21 per cent. The incidences of mite was low (<4%).
- g. **Rajasthan:** Pest survey was conducted at different crop growth stages (vegetative, reproductive and physiological maturity) in Rajsam and Udaipur districts of the Rajasthan. Mostly, CSV 15, CSV 23 and CSV 28 grown at farmers' field. Shoot fly infestation were recorded at low (5-10%) whereas in the hotspot nursery it was up to 60 per cent under late sown condition. Stem borer was moderate (8-16%) in the breeding trials. However, the infestation of other insect pest was sporadic viz. shoot bug, grass hopper and sorghum midge was recorded at very low level due to the continuity of rains during later crop growth stages. No intercrop with sorghum was noticed during Kharif 2013. No plant protection measures were undertaken by the farmers.
- h. **Haryana:** About 20 fields were surveyed for pest damage assessment in Hisar district. During Kharif, 2013 the insect pests problem in forage sorghum was not much alarming except stem borer infestation was maximum up to 42 per cent deadhearts in some of the susceptible genotypes. The shoot fly infestation remained low to moderate (up to 12 per cent deadhearts). No new pest was noticed; however, grasshopper and grey weevil were found infesting the crop with very low infestation and population (up to 3%).

#### Summary of pest situation in sorghum growing states-Kharif-2013-14

State	SFDH (%)	SBDH (%)	APHD (%)	SHBD (%)	HBD (%)	MIGD %	Remarks
Tamil Nadu	19.7	21.4	4.5	2.5	4.7	0.8	Mite damage was up to 3%
Andhra Pradesh	34.0	21.0	3.0	10.6	20	0.0	Low incidence of head worms (<3%), grasshoppers (<2%).
Karnataka	36.0	9.5	2.0	2.8	4.8	0.5	<i>Coccinellids</i> (0.50 %), Stem borer parasitization by <i>Cotesia flavipes</i> (7%).
Maharashtra	24.6	8.5	7.0	9.6	5.7	3.0	Grasshopper damage up to 5%
Madhya Pradesh	42.5	25.0	5.33	2.0	5.0	1.0	<i>Nezara</i> damage seen (< 5%).
Gujarat	28.0	9.0	2.0	1.0	2.0	2.0	Mite incidences increasing in south Gujarat (>10%) in some areas.
Rajasthan	7.0	11.0	2.0	2.0	1.0	0.5	Grasshoppers damage up to 7%
Haryana	9.0	30.0	7.0	3.04	2.1	1.00	Stem borer was predominant pest, <i>Pyrilla</i> damage (5%), Grasshoppers and grey weevils (~ 3%).



Note: The pest survey data collected by respective centers and confined to the respective areas only.

Promising entries with less susceptibility to key pests of grain and dual-purpose sorghum from different trials, Kharif- 2013 (Location: 6-9)

Trial	Shoot fly at peak stage (<45% DH) (IS 18551 30-35 DH %)	Stem borer at 45 DAE (<15% DH) IS 2205 10-12%	Head bug damage (rating 1-9) (1-3 rating)	Mite damage rating (1-9) (1-3 rating)	Overall resistant rating (1-9) (1-4)
AHT (GS)	SPH 1703	SPH 1736, SPH 1731, SPH 1736, CSH 30, LC	SPH 1702, SPH 1724, SPH 1730, SPH 1731, SPH 1736, SPH 1737, CSH 23, CSH 25, CSH 30.	DJ 6514, ICSV 745, SPH 1702, SPH 1705, SPH 1724, SPH 1730, SPH 1733, SPH 1736	SPH 1702, SPH 1730, SPH 1738, SPH 1737, CSH 25
AVT (GS)	NIL	SPV 2114, CSV 20, SPV 2174, SPV 2178, SPV 2182	SPV 2110, SPV 2122, SPV 2164, SPV 2170, SPV 2174, SPV 2175, SPV 2178, SPV 2179, SPV 2183, CSV 17, CSV 23, CSV 27	SPV 2170, CSV 23, CSV 27	SPV 2182
IHT (GS)	SPH 1748	SPH 1749, CSH 16	SPH 1748, SPH 1749, CSH 16, CSH 23	SPH 1749, CSH 23	Nil

Trial	Shoot fly at peak stage (<45% DH) (IS 18551 30-35 DH %)	Stem borer at 45 DAE (<15% DH) IS 2205 10-12%	Head bug damage (rating 1-9) (1-3 rating)	Mite damage rating (1-9) (1-3 rating)	Overall resistant rating (1-9) (1-4)
IVT (GS)	Nil	Nil	<u>SPV 2244</u> , <u>SPV 2247</u> , <u>SPV 2249</u> , <u>SPV 2250</u> , <u>SPV 2251</u> .	SPV 2242, <u>SPV 2244</u> , <u>SPV 2245</u> , <u>SPV 2256</u> , <u>SPV 2250</u> , <u>SPV 2251</u> , <u>SPV 2255</u> , <u>SPV 2256</u> , CSV 17	SPV 2243, CSV 27
IAVHT (MC)	<u>SPH 1695</u> , and CSH 24MF	<u>SPH 1695</u> , <u>SPH 1698</u> , <u>SPH 1752</u> , <u>SPH 1753</u> , <u>SPV 2242</u> , <u>SSG 59-3</u> , CSH 20MF, local check	Nil	SPH 1715, <u>SPH 1753</u> , <u>SPV 2242</u> , CSH 20MF and CSH 24MF	
AVT (SC)	SPV 2186, CSV 21F, <u>SPV 2191</u> , HC 308, LC	CSV 21F, <u>SPV 2191</u> and ICSV 745	Nil	SPV 2185, CSV 21F, HC 308, Swarna, and DJ 6514	Nil
IVHT (SC)	<u>SPV 2258</u> , SPV 2265, SPV 2266	<u>SPV 2258</u>	Nil	SPV 2257, local check and DJ 6514	Nil
IAVHT (SS)	Nil	CSV 19SS	Nil	SPV 2196, SPV 2205, SPV 2267, SPV 2269, SPV 2270, SPH 1755, CSV 24SS and CSH 22SS	Nil
AICSIP-SPN	SPV 2196, SPV 2203, SPV 2204 and RSSV 9	SPV 2114, SPV 2122, SPV 2057, SPV 2127, SPV 2130, SPV 2131, SPV 2132, SPV 2186, SPV 2197, SPV 2198			
Elite-DP	LDR 238, <u>PGN 39</u> , <u>RSSV 9</u> , <u>SUENT 13</u> , <u>EC 15</u> , ICSB 411, ICSV 705, <u>ICSV 93046</u> , IS 2123, IS 2146	P 23, P 45, PGN 30, <u>PGN 39</u> , PGN 61, <u>RSSV 9</u> , Satpani, PGN 111, <u>EC 15</u> , EP 96, <u>ICSV 93046</u> , IS 2123			P 23, PGN 4RED, RSSV 9, SUENT 13, AKR 354, IEC 15, ICSV 12001, ICSV 25022, ICSV 93646, IS 2146
DSR-SPRN)	M 35-1 x ICSV 714)-3-1-1, ( <u>M 35-1 x IS 2312-1</u> )-3-2-2, and ( <u>ICSV 700 x ICSV 705</u> )-1-1-1	(PGN 35 x PGN 30)-3-2,(EC 15 x ICSV 714)-2-1-2, (ICSV 700 x IS 2205-1)-3-1-2,and ( <u>ICSV 700 x ICSV 705</u> )-1-1-1	(EC 60 x IS 18551)-3-1-3, (ICSV 700 x IS 2205-1)-3-1-1, (ICSV 700 x ICSV 705)-1-2-1, ( <u>M-35-1 x IS 2312-1</u> )-3-2-2		EC 15 x ICSV 714)-2-1-2 and (M-35-1 x ICSV 714)-3-1-1
Forage-SF	CO (FS)-29, CSV 21F, Ramkel, Katakhatav, RSSV 9, Rampur local and Sangoli Hundi.				CO (FS)-29, SSG 59-3, IS 2205 and IS2312
PDRN-SF	NRCS-FR09-3, RSSV 9 and SUENT 13	GMR 144-2 and GMR 156			GMR 308

*Note: Underlined entries recorded as resistant/tolerance to more than one pest*

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

The breeding materials through two advanced trials viz., AHT and AVT and two initial trials viz., IHT and IVT on grain sorghums were evaluated across the locations for resistance against key pests. Total 83 entries including desirable checks were evaluated for resistance against shoot fly, stem borer and other pests. It is to note that 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 evaluate AICSIP trials at hot spot locations for desirable pests. In all entomology trials, zones as decided by the breeding program, could not be considered while analyzing data, since hot spots are not matching with the zones.

### Trial 1: Advance Hybrid Trial (AHT-GS) (Locations: 9)

The trial AHT-GS consisted of nineteen entries of which nine experimental hybrids, four released hybrid checks (CSHs 16, 23, 25 and 30) one local check from respective centers, three resistant checks for different pests (IS 2205, IS 18551, ICSV 745) and two susceptible checks (DJ 6514, Swarna) were evaluated at nine locations (Palem, Coimbatore, Udaipur, Parbhani, Akola, Dharwad, Indore, Surat and Hisar) for resistance/susceptibility to key pests.

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly was recorded at peak stage at nine locations (Palem, Coimbatore, Udaipur, Parbhani, Akola, Dharwad, Rahuri, Indore, and Surat). The data on shoot fly generated at Coimbatore and Udaipur could not be considered due to high CV (> 25.0%), These centers along with Indore also rejected due to low deadhearts percent (<70%) in susceptible check Swarna. At Akola, the range of shoot fly deadhearts was from 42.1 to 92.4 with an average of 78.8 %. None of the test entries were superior to resistant check (IS 18551). The infestation in the form of deadhearts due to shoot fly at Parbhani was ranged from 50.7 to 87.0 % with an average of 77.9%. None of the test entries were on par with resistant checks IS 18551. At Palem the range was from 45.4 to 96.9 with an average of 77.4%. The entry SPH 1703 (48.9%) recorded relatively lower deadhearts and was on par with resistant check IS 18551 that recorded 45.3% deadhearts. At Surat, the shoot fly deadhearts range was from 32.1 to 87.2 % with an average of 49.0 % deadhearts. The entries SPH 1703, SPH 1705, SPH 1724, CHS 23 and CSH 30 were on par with resistant check IS 18551. At Rahuri, the per cent of deadhearts was ranged from 44.2 to 82.1% with an average of 63.5%. The entries those were not different from resistant check IS 18551 are SPH 1703, SPH 705, SPH 1724, SPH 1731, CSH 16, CSH 23 and CSH 25. At Dharwad the range of shoot fly deadhearts ranged from 71.0 to 100.0 % with an average of 88.7 % deadhearts. The entries SPH 1705 and SPH 1730 recorded relatively low damage and were on par with resistant check IS 18551 (Table 1.1).

At National level, across the locations, the mean shoot fly deadheart formation was 72.6 % with a range of 47.6-86.7%. None of the entries was significantly superior to resistant check IS 18551 or IS 2205. However SPH 1703 recorded lower damage (62.1%) (Table 1.1)

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Udaipur, Palem, Rahuri, Indore and Dharwad. The data was not significant except at Dharwad. The range at Dharwad was from 3.0 to 6.7 eggs on 5 plants averaging 4.7 eggs. The lowest eggs (< 4 eggs) were recorded in CSH 25, CSH 16, SPH 1733, SPH 1739 and SPH 1724. Across the locations, the range was from 9.5 to 12.1 eggs/5 pts averaging 11/0 eggs. The data was not significant at 5% level. The lowest eggs were recorded in CSV 17 (Table 1.1).

**Morpho-physiological traits:** Morpho-physiological traits such as seedling vigor and leaf glossiness were recorded. The data on leaf glossiness at 12 days after emergence was recorded at Akola, Parbhani, Palem, Rahuri, Indore and Dharwad during Kharif 2013. The data recorded at all locations were significant at 5% level except Palem and Indore. Across the locations, the data was significant at 5% level and showed range from 2.5 to 3.7 with an average of 3.21. Across the locations, the test entries that recorded high glossiness are SPH 1703 and CSH 30 and not different from resistant check. The seedling vigor at 12 days after emergence recorded at Parbhani, Udaipur, Surat, Palem, Rahuri, Indore and Dharwad. The data at Parbhani, Palem and Surat was significant at 5% level. However, across the locations, the data was not significant at 5% level. Overall, the range was from 2.57 to 3.43 with an average of 3.10. The entries that recorded <3 vigor rating are CSH 16, CSH 25 and ICSV 745 (Table 1.3).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on stem borer on different parameters was recorded at five centers. The data on spotted stem borer infestation was recorded in terms of damage rating (1-9) at 35 DAE, deadhearts (%) at 45 DAE, stem tunneling (%) at harvest. The data on injury rating (1-9) was recorded at four locations viz., Coimbatore, Surat, Rahuri, and Indore. The data recorded at Rahuri, Coimbatore and Surat was not significant at 5% level. Whereas, the data recorded at Indore was significant at 5% level but CV % was more than 25%. Across the locations, the range of leaf injury was from 3.58 to 5.17 with an average of 4.26 in the scale of 1-9. However the range of injury rating was narrow. The entries SPH 1731, SPH 1733 and CSH 16 recorded <4 injury rating and were on par with resistant check IS 18551 (Table 1.2). The data on stem tunneling due to borer was recorded during harvest at Coimbatore and Indore. The data recorded at Coimbatore was not significant at 5% level and possessed high CV % (>25%). Across the locations the tunneling % ranged from 4.6 – 29.5 % with an average of 16.3%. The entries SPH 1702, IS 18551 and ICSV 745 recorded low tunneling % and were on par with resistant check (Table 1.2).

The data on deadhearts at 45 DAE due to stem borer was recorded at Parbhani, Coimbatore, Surat, Rahuri and Indore. The data recorded at Parbhani, Coimbatore and Surat has high CV%, hence could not be considered for discussions. The data recorded at Rahuri and Indore was significant at 5% level. The data at Indore could not consider for national mean due to its unusual and high stem borer deadhearts %. Though, the data was significant at 5% level. It may be interesting to study the causes of such high incidence of stem borer at Indore. It needs for further confirmation. Across the locations, the DH% due to stem borer was ranged 4.56 to 14.54 % with an average of 8.64 %. The entries that recorded lowest deadhearts % are SPH 1736, SPH 1731, SPH 1736, CSH 30 and local checks and were on par with resistant check (Table 1.2).

**Midge (*Stenodiplosis sorghicola* Coq):** This season, no damage was seen due to midge at AICSIP centre during Kharif 2013.

**Head bug (*Calocoris angustatus*):** The damage due to head bug was recorded in the scale of 1-9. The damage rating at milk stage was recorded at Palem and Indore. At Palem, the data was not significant at 5% level. Across the locations the damage rating was low with a mean of (3.95). The range of damage rating was from 2.33-5.17. The test entries that recorded damage up to 4 are: SPH 1702, SPH 1724, SPH 1730, SPH 1731, SPH 1736, SPH 1737 CSH 23, CSH 25 and CSH 30. These entries were on par with resistant check (IS 18551) that recorded 2.3 damage rating (Table 1.1).

**Shoot bug (*Peregrinus maidis*):** There was no recordable damage due to shoot bug at AICSIP centre during Kharif 2013.

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** Mite is an emerging pest in South Gujarat on Sorghum. Therefore evaluation studies were carried out at Surat. The data on mite damage rating was recorded in the scale of 1-9. The damage was ranging from 2.00 to 7.67 averaging 2.72. The data was statistically significant at 0.05 levels. The DJ 6514, ICSV 745, SPHs 1702, 1705, 1724, 1730, 1733, and 1736 recorded lowest damage (2.00) and the entries found on par with DJ 6514 which is resistant check for mites (Table 1.4).

**Plant population per plot (2.4 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at Akola, Parbhani, Udaipur, Coimbatore, Palem, Surat, Rahuri and Indore. The data on plant population at Udaipur, Surat, Rahuri and Indore was not significant at 5% level. Across the locations, the data on plant stand was significant and ranged from 16.6 to 25.8 plants plot<sup>-1</sup> with an average of 21.0 plants plot<sup>-1</sup> (Table 1.3).

**Days to 50 % flowering:** Days to 50% flowering were recorded at Parbhani, Surat and Indore. Across the locations the data was not significant at 5% level. However, across the locations and genotypes, among the entire test entries, DJ 654 was longest (92 days) flowering followed by IS SPH 1731 (90.2 days). The entry that recorded earliest flowering (83 days) was SPH 1724 followed by SPH 1705 (84 days) (Table 1.4).

**Grain yield & its components:** Grain yield in grams per five plants was assessed at Surat and Indore. The yield was affected when the test entries were exposed to biotic stresses especially shoot fly and stem borers. Overall, the yield was ranged from 201-367 g 5 plants<sup>-1</sup> the mean grain yield was 268 g 5 plants<sup>-1</sup>. The entries that

recorded higher yield (>350 g 5 plants<sup>-1</sup>) were CSH 30, CSH 16 and SPH 1705. However, across the locations, the data was not significant at 5% level (Table 1.4).

**Overall resistant rating:** The data on overall rating on resistance was recorded at Parbhani, Palem and Indore was significant at 5 % level at Parbhani and Indore. Across the locations and genotypes, the range was from 373 -7.62 with an average of 5.33. The entries recorded high resistant recovery (<5) are SPH 1702, SPH 1730, SPH 1738, SPH 1737, CSH 25, IS 18551 and IS 2205 (Table 1.4).

#### **Trial 2: Advance Varietal Trial (AVT-GS) (Locations: 9)**

The trial AVT-GS consisted of twenty six entries of which sixteen experimental varieties, four released varieties checks (CSVs 17, 20, 23 and 27) one local check from respective centers, three resistant checks for different pests (IS 2205, IS 18551, ICSV 745) and two susceptible checks (DJ 6514, Swarna) were evaluated at nine locations (Palem, Coimbatore, Udaipur, Parbhani, Akola, Dharwad, Rahuri, Indore and Surat) for resistance/susceptibility to key pests.

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly was recorded at peak stage at nine locations (Palem, Coimbatore, Udaipur, Parbhani, Akola, Dharwad, Rahuri, Indore, and Surat). The data on shoot fly generated at Coimbatore and Udaipur could not be considered owing to low infestation of shoot fly in susceptible check (<70% DH). At Akola, the range of shoot fly deadhearts ranged from 46.0 to 93.7 with an average of 82.3 % deadhearts. None of the test entries were superior to resistant check (IS 18551). The deadheart at Parbhani ranged from 43.8 to 88.2 % with an average of 79.5 % deadhearts. None of the test entries were on par with resistant checks IS 18551. At Palem, the range was from 44.5 to 100.0 with an average of 70.3%. The entries SPV 2110, SPV 2165, SPV 2178, SPV 2181, SPV 2184 and CSV 27 recorded relatively lower deadhearts% and were on par with resistant check IS 2205 (44.5%). At Surat, the range of shoot fly deadhearts was from 24.9 to 79.1 % with an average of 43.5 % deadhearts. The entries SPV 1822, SPV 2110, SPV 2164, SPV 2165, SPV 2174, SPV 2182, SPV 2183, CSV 23 had lower deadhearts percent and were on par with resistant check IS 18551. At Rahuri, the % of deadhearts was ranged from 36.2 to 82.1% with an average of 60.5%. The entries that were not different from resistant check, IS 18551 are SPV 2110, SPV 2164, SPV 2184 and CSV 17. At Indore the range of shoot fly deadhearts was from 51.3 to 95.5% with an average of 77.4 %. The entries that had lowest deadhearts were SPV 2183, CSV 27 and local check. At Dharwad, the range of shoot fly deadhearts ranged from 55.4 to 96.4 with an average of 80.4 % deadhearts. The entry SPV 2175, and SPV 2165 recorded lowest deadhearts % and were on par with resistant check IS 18551 (Table 2.1).

At National level, across the locations, the data was significant at 5% level; the mean deadheart due to shoot fly formation was 70.6 %, range being 43.2- 89.5%. None of the entries was significantly superior to resistant check IS 18551 or IS 2205 (Table 2.1)

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Palem, Udaipur, Rahuri, Dharwad and Indore. Across the locations, the range was 6.73 to 12.33 eggs/5 pts averaging 9.0 eggs/5 plants. The data was not significant at 5% level. The lowest eggs were recorded in CSV 17 (Table 2.1).

**Morpho-physiological traits:** Morpho-physiological traits such as seedling vigor and leaf glossiness have been recorded in the scale of 1 to 5. The leaf glossiness was recorded at Akola, Parbhani, Palem, Rahuri, Indore and Dharwad during Kharif 2013. Across the locations there was no significant difference between resistant check and the test entries for leaf glossiness at 12 days after emergence. The range was from 2.5 to 3.5 with an average of 3.1 in the scale of 1-5. The seedling vigor at 12 days after emergence recorded at Parbhani, Udaipur, Surat, Rahuri, Indore and Dharwad. Overall the data was not significant at 5% level. The range was from 2.6 to 3.3 with an average of 3.0 (Table 2.3).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on stem borer infestation was assessed in terms of stem borer leaf injury rating (1-9) at 35 days after emergence, deadhearts (%) at 45 DAE, stem tunneling (%) at hot spot locations. The data on injury rating (1-9) was recorded at Akola, Coimbatore, Surat, Rahuri and Indore. The CV % was above 25% at Akola, Surat, Rahuri, and Indore and hence could not consider. The data at Coimbatore was significant at 5% level. The range was 4.00 to 6.67 with an average of 5.50 in the scale of 1-9.

The entries SPV 2110, SPV 2165, SPV 2174, SPV 2182 and CSV 20 recorded <5 rating at Coimbatore. Across the locations, the data on leaf injury rating was non-significant and ranged from 3.47 to 5.07 with an average of 4.26. Among the test entries, SPV 2165 recorded lowest leaf injury (3.73) in the scale of 1-9 (Table 2.2).

The data on stem tunneling % due to borer was recorded at Coimbatore and Indore centers. Severe damage was recorded at Coimbatore (up to 53.8%) in local check. The data at Coimbatore center had high CV % (>25%) and hence could not consider. Across the locations the damage ranged from 3.9 – 30.0 %, the mean being 18.4%. The entries SPV 2110, SPV 2122, CSV 17, CSV 27 and ICSV 645 recorded low stem tunneling % and were on par with resistant check (Table 2.2).

The data on deadhearts at 45 DAE was recorded at Parbhani, Coimbatore, Palem, Surat, Rahuri and Indore. The CV% at other centers except Indore was above 25% and hence could not consider. At Indore the deadhearts due to stem borer was very high ranging from 47.6 to 79.6% averaging 64.5% and therefore, could not consider for national mean. Overall the range was 4.9 -15.12% with an average of 9.3%. The entries, SPV 2114, CSV 20, SPV 2174, SPV 2178, SPV 2182 recorded lowest deadhearts (<8 %) and was on par with resistant check. The CV % was > 25% at national level (Table 2.2).

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

**Head bug (*Calocoris angustatus*):** The damage due to head bug was recorded in the scale of 1-9. The damage rating at milk stage was recorded at Palem and Indore. Across the locations the damage rating was low with a mean of (3.8). The range of damage rating was from 2.33-5.33. The test entries that recorded up to 4 damage rating are: SPV 2110, SPV 2122, SPV 2164, SPV 2170, SPV 2174, SPV 2175, SPV 2178, SPV 2179, SPV 2183, CSV 17, CSV 23, CSV 27 and local check. The check (IS 18551) recorded 2.5 damage rating (Table 2.1).

**Shoot bug (*Peregrinus maidis*):** There was no recordable damage due to shoot bug at AICSIP centre during Kharif 2013.

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** Mite is an emerging pest in South Gujarat on Sorghum. Therefore evaluation studies were carried out at Surat. The data on mite damage rating was recorded in the scale of 1-9. The damage was ranging from 1.33 to 7.67 averaging 4.51. The data was statistically significant at 5% level. The DJ 6514 and Swarna recorded lowest damage (2.00) and the entries found on par with this are SPV 2170, CSV 23 and CSV 27 (Table 2.4).

**Plant population per plot (2.4 m<sup>2</sup>):** The data on plant population per plot (2 row of 2 m) was recorded at nine centers Palem, Akola, Parbhani, Dharwad, Coimbatore, Surat, Rahuri, Indore and Udaipur. Across the locations, the data on plant stand was ranged from 18.9 to 28.9 plants plot<sup>-1</sup> with an average of 23.3 plant plot<sup>-1</sup>. The CV was very high (60.5%) at Udaipur and as results it was reflected on pest incidence % especially on shoot fly infestation (Table 2.3).

**Days to 50 % flowering:** Days to 50% flowering were recorded at Parbhani, Surat and Indore. Across the locations and genotypes, among the entire test entries, CSV 17 was earliest (86 days) flowering followed by IS 2122 (86.2 days). The entry that recorded longest duration (>95 days) was ICSV 745 (Table 2.4).

**Grain yield & its components:** Grain yield in grams per five plants was assessed at Surat and Indore. When the test entries were exposed to biotic stresses, especially insect pests, the yield ranged from 231-399 g 5 plants<sup>-1</sup> the mean grain yield was 303 g 5 plants<sup>-1</sup>. The entries that recorded higher yield (>350 g 5 plants<sup>-1</sup>) were SPV 2174, and SPV 2175 (Table 2.4).

**Overall resistant rating:** The data on overall rating on resistance was recorded at Parbhani and Indore was significant at 5 % level at Parbhani. Overall the range was from 3.00 -6.50 averaging of 6.0. None of the entries other than resistant checks recorded <5 rating. The lowest rating after the resistant check was recorded in SPV 2182 (5.33) (Table 2.4).

### **Trial 3: Initial Hybrid Trial (IHT-GS) (Locations: 9)**

The trial IHT-GS consisted of thirteen entries of which four experimental hybrids, four released hybrid checks (CSHs 16, 23, 25 and 30), three resistant checks for different pests (IS 2205, IS 18551, ICSV 745) and two susceptible checks (DJ 6514, Swarna) were evaluated at nine locations (Palem, Coimbatore, Udaipur, Parbhani, Akola, Dharwad, Indore, Rahuri, Surat) for resistance/susceptibility to key pests. No local check was incorporated.

**Shoot fly (*Atherigona soccata* Rondani):** Deadhearts caused due to shoot fly was recorded at peak stage at nine locations (Palem, Coimbatore, Udaipur, Parbhani, Akola, Dharwad, Rahuri, Indore and Surat). The data on shoot fly generated at Coimbatore could not be considered due to high CV (> 25.0%) and lower deadhearts in susceptible check. The centers Udaipur and Akola also rejected due to low deadhearts percent (<70%) in susceptible check Swarna. The infestation in form of deadheart due to shoot fly at Parbhani was ranged from 55.4 to 85.7 % with an average of 78.2%. None of the test entries were on par with resistant checks IS 18551. At Palem the range was from 64.1 to 100.0 with an average of 81.7%. The entry CSH 30 (66.9%) recorded relatively lower deadhearts and was on par with resistant check IS 18551 that recorded 64.1% deadhearts. At Surat the data on shoot fly deadhearts was significant at 5% level. The range was from 42.0 to 91.8 % with an average of 59.0 % deadhearts. The entries SPH 1748, CSH 23, and CSH 30 recorded <50% deadhearts and were on par with resistant check IS 18551. At Rahuri, the % of deadhearts was ranged from 44.6 to 77.5% with an average of 58.8%. At Rahuri, the entries those were not different from resistant check IS 18551 are SPH 1748, CSH 16, CSH25, ICSV 745 and recorded <50% deadhearts. At Indore, the range of deadhearts was quite high and from 73.9 to 87.7 with an average of 81.4%. At Dharwad also the range of shoot fly deadhearts was quite high and it was from 77.8 to 95.5 % with an average of 87.3 % deadhearts. The data at Dharwad and Indore was not significant at 5% level (Table 3.1).

At National level, across the locations, the mean shoot fly deadheart formation was 74.6 % with a range of 60.5-88.1%. The only one entry SPH 1748 recorded lowest deadhearts % (68.3%) and was not different from resistant check IS 18551. The data on shoot fly deadhearts% was significant at 5% level (Table 3.1)

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Udaipur, Palem, Rahuri, Indore and Dharwad. The data at Palem, Rahuri and Indore was not significant at 5% level and had high CV%. Across the locations, the range was from 7.7 to 13.4 eggs/5 pts averaging 9.3 eggs. The data was not significant at 5% level. All entries except susceptible checks recorded <10 eggs per 5 plants and were on par with resistant check IS 18551 (Table 3.1).

**Morpho-physiological traits:** Morpho-physiological traits such as seedling vigor and leaf glossiness have been recorded. The data on leaf glossiness at 12 days after emergence was recorded at Akola, Parbhani, Palem, Rahuri, Indore and Dharwad during Kharif 2013. The data recorded at all locations were significant at 5% level except at Palem, Dharwad and Indore. Across the locations, the data was not significant at 5% level and showed range from 2.42 to 3.38 with an average of 3.04. Across the locations, the test entries that recorded high glossiness are CSH 16, ICSV 745, IS 2205 (<3 rating). The seedling vigor at 12 days after emergence was recorded at Parbhani, Udaipur, Surat, Palem, Rahuri, Indore and Dharwad. The data at all contest were significant at 5% level except at Indore. However, across the locations, the data was not significant at 5% level. Overall, the range was from 2.81 to 3.67 with an average of 3.29. The entries that recorded <3 vigor rating are SPH 1751, IS 18551, IS 2205, ICSV 745 (Table 3.2).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on stem borer on different parameters was recorded at six centers. The data on spotted stem borer infestation was recorded in terms of damage rating (1-9) at 35 DAE, deadhearts (%) at 45 DAE, stem tunneling (%) at harvest. The data on injury rating (1-9) was recorded at five locations viz., Akola, Coimbatore, Surat, Rahuri, and Indore. The data recorded at all locations were not significant at 5% level except Surat. The range of leaf injury recorded at Surat was from 3.00 to 7.33 with an average of 4.92 in the scale of 1-9. Across, the locations, the data was not significant. The range of leaf injury was from 3.47 to 4.47 with an average of 3.91 in the scale of 1-9. However the range of injury rating was narrow. The entry SPH 1749 recorded lowest leaf injury (Table 3.3).

The data on per cent stem tunneling due to borer was recorded during harvest at Coimbatore and Indore. The data recorded at Coimbatore was not significant at 5% level and possessed very high CV % (100%). At Indore, the data ranged from 4.23 to 7.60 with an average of 6.72%. Across the locations the tunneling % was not significant and it ranged from 6.6 – 22.6 % with an average of 14.9 %. The entries SPH 1750 and SPH recorded low tunneling % (<8%), (Table 3.4).

The data on deadhearts at 45 DAE due to stem borer was recorded at Parbhani, Coimbatore, Palem, Surat, Rahuri and Indore. The CV at all locations was very high (>25%) except at Indore and therefore, could not consider. However, the data recorded at Parbhani, Coimbatore, Surat and Indore was significant at 5%. Across the locations, the DH% due to stem borer was ranged 5.4 to 14.0 % with an average of 9.8 % and was significant at 5% level. The entries that recorded <10% deadhearts are SPH 1749 and CSH 16. However CV % recorded about 31% (Table 3.3).

**Midge (*Stenodiplosis sorghicola* Coq):** This season, no damage was seen due to midge at AICSIP centre during Kharif 2013.

**Head bug (*Calocoris angustatus*):** The damage due to head bug was recorded in the scale of 1-9. The damage rating at milk stage was recorded at Palem and Indore. At Palem, the data was not significant at 5% level. Across the locations the damage rating was low with a mean of (3.9). The range of damage rating was from 2.67-4.33. The test entries that recorded damage up to 4 are: SPH 1748, SPH 1749, CSH 16 and CSH 23. These entries were on par with resistant check (IS 18551) that recorded 2.67 damage rating (Table 3.1).

**Shoot bug (*Peregrinus maidis*):** There was no recordable damage due to shoot bug at AICSIP centre during Kharif 2013.

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** Mite is an emerging pest in South Gujarat on Sorghum. The data on mite damage rating was recorded in the scale of 1-9. The damage was ranging from 1.67 to 7.33 averaging 2.69. The data was statistically significant at 5% level. Most of the entries had damage rating of 2. But two entries SPH 1749 and CSH 23 recorded <2 rating and did significantly different from the resistant check DJ 6514. Here IS 18551 recorded highest damage rating (7.33) followed by IS 2205 (Table 3.4).

**Plant population per plot (2.4 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at Akola, Parbhani, Udaipur, Coimbatore, Palem, Surat, Rahuri, Dharwad and Indore. The data on plant population at Udaipur, Surat, Coimbatore, Rahuri and Indore was not significant at 5% level. Across the locations, the data on plant stand was significant and ranged from 15.1 to 27.0 plants plot<sup>-1</sup> with an average of 20.9 plants plot<sup>-1</sup> (Table 3.2)

**Days to 50 % flowering:** Days to 50% flowering were recorded at Parbhani, Surat and Indore. Across the locations the data was not significant at 5% level. However, among the entire test entries, ICSV 745 recorded longest flowering (92 days) and followed by DJ 654 (90 days). The entry CSH 16 recorded earliest flowering (82 days) and was followed by CSH 23 (83 days) (Table 3.4).

**Grain yield & its components:** Grain yield in grams per five plants was assessed at Surat and Indore. The yield was affected when the test entries were exposed to biotic stresses especially shoot fly and stem borers. Overall, the yield was ranged from 174-353 g 5 plants<sup>-1</sup> and the mean grain yield was 267 g 5 plants<sup>-1</sup>. The entries that recorded higher yield (>350 g 5 plants<sup>-1</sup>) were SPH 1750 and ICSV 745. However, across the locations, the data was not significant at 5% level (Table 3.4).

**Overall resistant rating:** The data on overall rating on resistance was recorded at Parbhani and Indore. The data was significant at 5 % level at Parbhani and Indore. Across the locations and genotypes, the range was from 3.00 -700 with an average of 5.54. The resistant check IS 18551 and IS 2205 recorded highest resistant recovery (<5). None of the entries recorded highest resistant rating (<5) other than IS 18551 and IS 2205 (Table 3.4).

#### **Trial 4: Initial Varietal Trial (IVT-GS) (Locations: 9)**

The trial IVT-GS consisted of twenty five entries of which fifteen experimental varieties, four released varieties checks (CSVs 17, 20, 23 and 27) one local check from respective centers, three resistant checks for different pests (IS 2205, IS 18551, ICSV 745) and two susceptible checks (DJ 6514, Swarna) were evaluated at nine locations (Palem, Coimbatore, Udaipur, Parbhani, Akola, Dharwad, Rahuri, Indore and Surat) for resistance/susceptibility to key pests.

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly was recorded at peak stage at nine locations (Palem, Coimbatore, Udaipur, Parbhani, Akola, Dharwad, Rahuri, Indore, and Surat). The data on shoot fly generated at Coimbatore and Rahuri could not consider owing to low infestation of shoot fly in susceptible check (<70% DH). At Akola, the range of shoot fly deadhearts ranged from 37.3 to 71.3 with an average of 52.9 % deadhearts. The data of fifteen test entries were recorded up to 57% deadhearts and on par with resistant check IS 18551. The deadheart at Parbhani ranged from 47.2 to 86.6 % with an average of 78.4 % deadhearts. None of the test entries were on par with resistant checks IS 18551. At Palem, the range was from 43.7 to 96.8 with an average of 65.2%. The entries SPV 2254/ICSV 745, SPV 2249, SPV 2242, SPV 2243 and SPV 2253 recorded relatively lower deadhearts % and were on par with resistant check IS 18551 (43.7%). At Surat the range of shoot fly deadhearts was from 37.0 to 86.5 % with an average of 56.4% deadhearts. The entries SPV 2243, SPV 2244, SPV 2249 and SPV 2256 had lower deadhearts per cent and were on par with resistant check IS 18551. At Indore, the percent deadhearts was ranged from 56.0 to 86.3% with an average of 72.4%. The entries that had lowest deadhearts were SPV 2250 and ICSV 745 and recorded at par with resistant check. While at Dharwad, highest mean of deadhearts % was recorded (85.9%), ranging from 71.4 to 94.4% deadhearts. Among the test entries, the SPV 2256 recorded lowest deadhearts ((71.4 %) and on par to resistant check IS 18551 (Table 4.1).

At National level, across the locations, the data was significant at 5% level; the mean deadheart due to shoot fly formation was 63.0 %, range being 46.5- 79.0%. None of the entries was significantly superior to resistant check IS 18551 or IS 2205 (Table 4.1)

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at six locations viz., Udaipur, Palem Rahuri, Dharwad and Indore. The CV was recorded > 25% at Palem, Indore and Dharwad, therefore could not consider while discussion. Across the locations, the range was 7.1 to 14.3 eggs/5 pts averaging 9.6 eggs/5 plants. The data was not significant at 5% level. The lowest eggs were recorded in respective local checks (7.3 eggs/5 plants) (Table 4.1).

**Morpho-physiological traits:** Morpho-physiological traits such as seedling vigor and leaf glossiness were recorded in the scale of 1 to 5. The leaf glossiness was recorded at Akola, Parbhani, Palem, Rahuri, Indore and Dharwad. Across the locations, the data was significant at 5% level. Across the locations, the range was from 2.08 to 3.57 with an average of 3.21 in the scale of 1-5. The test entries SPV 2254 and SPV 2248 high leaf glossiness (about 3), The data on seedling vigor was recorded at 12 days after emergence at Parbhani, Udaipur, Palem, Surat, Rahuri, Indore and Dharwad. Overall the data was not significant at 5% level. The range was from 2.17 to 3.36 with an average of 2.78. The test entries SPV 2255 and SPV 2245 recorded highest seedling vigor after resistant check IS 18551 (Table 4.3).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on stem borer infestation was assessed in terms of stem borer leaf injury rating (1-9) at 35 days after emergence, deadhearts (%) at 45 DAE, stem tunneling (%) at hot spot locations. The data on injury rating (1-9) was recorded at Akola, Coimbatore, Surat, Rahuri and Indore. The CV % was > 25% at Akola, Surat, and Indore and therefore rejected. The data at Indore was not significant at 5% level. At Rahuri, the range was very low from 2.00 to 3.00 with an average of 2.37 in the scale of 1-9. Across the locations, the data on leaf injury rating was non-significant and ranged from 3.00 to 4.53 with an average of 3.74. The entry SPV 2242 recorded lowest leaf injury (3.27) in the scale of 1-9 (Table 4.2).

The data on stem tunneling % due to borer was recorded at Coimbatore and Indore centers. Severe damage was recorded at Coimbatore (up to 55.0% in SPV 2248). The data at Coimbatore center had high CV % (83%) and hence could not consider. At Indore, the range was from 4.2 to 8.3% with an average of 7.0%. Across the

locations the damage range was from 6.3 to 31.4 averaging 17.0%. However, the CV was high (>25%). The entries SPV 2244, SPV 2250 and SPV 2254 recorded low stem tunneling (<10 %) and were on par with resistant check IS 18551. It is surprising to note that IS 2205, resistant check recorded 17.5% stem tunneling damage due to stem borer (Table 4.2).

The data on deadhearts at 45 DAE was recorded at Parbhani, Coimbatore, Palem, Surat, Rahuri and Indore. The CV% at all centers except Indore was above 25% and therefore rejected. At Indore the deadhearts due to stem borer was very high ranging from 43.2 to 78.6% averaging 68.6%. It may be interesting to study the causes of such high incidence of stem borer at Indore. Across the locations, the range was 11.9 to 22.6% with an average of 18.6%. No single test entry was recorded low deadhearts on par with resistant check (Table 4.2).

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

**Head bug (*Calocoris angustatus*):** The damage due to head bug was recorded in the scale of 1-9. The damage rating at milk stage was recorded at Palem and Indore. Across the locations the damage rating was low with a mean of (3.0). The range of damage rating was from 1.50 to 4.50. The test entries that recorded up to 3 damage rating are: SPV 2244, SPV 2247, SPV 2249, SPV 2250 and SPV 2251. The check (IS 18551) recorded 1.5 damage rating in the scale of 1-9 (Table 4.1).

**Shoot bug (*Peregrinus maidis*):** There was no recordable damage due to shoot bug at AICSIP centre during Kharif 2013.

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on mite damage rating was recorded at Surat in the scale of 1-9. The damage rating was ranging from 1.00 to 7.33 averaging 1.80. The data was statistically significant at 0.05 levels. The DJ 6514 recorded lowest damage (1.00) and the entries found on par with the resistant check DJ 6514 are SPVs 2242, 2244, 2245, 2256, 2250, 2251, 2255, 2256 and CSV 17 (Table 4.4).

**Plant population per plot (2.4 m<sup>2</sup>):** The data on plant population per plot (2 row of 2 m) was recorded at nine centers Palem, Akola, Parbhani, Dharwad, Coimbatore, Surat, Rahuri, Indore and Udaipur. Across the locations, the data on plant stand was ranged from 18.2 to 23.9 plants plot<sup>-1</sup> with an average of 20.9 plant plot<sup>-1</sup>. The CV was very high at Udaipur and Palem (>25%) as results it was reflected on pest incidence % especially for shoot fly (Table 4.3).

**Days to 50 % flowering:** Days to 50% flowering were recorded at Parbhani, Surat and Indore. Across the locations and genotypes, among the entire test entries, CSV 17 recorded earliest flowering (86 days) and followed by IS 2242 (89 days). The entry that recorded most delayed flowering (94 days) was CSV 23 (Table 4.4).

**Grain yield & its components:** Grain yield in grams per five plants was assessed at Surat and Indore. Across the locations, yield ranged from 111-296 g 5 plants<sup>-1</sup> and the mean grain yield was 215 g 5 plants<sup>-1</sup>. The entries that recorded higher yield (>250 g 5 plants<sup>-1</sup>) were SPV 2243, CSV 17, DJ 6514 and ICSV 745 (Table 4.4).

**Overall resistant rating:** The data on overall rating on resistance was recorded at Parbhani and Indore. The data on resistant rating was significant at 5 % level. Across the locations, the range was from 2.83 to 8.00 averaging of 5.47. The test entries SPV 2243, CSV 27 and local check recorded higher recovery resistant (4.3) and was not differed from resistant check IS 18551 (Table 4.4).

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

Three forage sorghum trials viz. IVHT (multi-cut), AVT (single-cut) and IVHT (single-cut), were evaluated across the zones at six locations (Coimbatore, Udaipur, Hisar, Dharwad, Akola and Surat). Total 58 entries including checks were evaluated for resistance against shoot fly, stem borer and other pests. It is to note that Surat center has 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.

#### **Trial 5: Initial and Advanced Varietal and Hybrid Trial (IAVHT-Forage-Multi-cut) (Locations: 6)**

The trial IAVHT-MC consisted of twenty two entries of which twelve experimental varieties, one hybrid, three released checks (SSG 59-3, CSH 20MF, CSH 24MF), one local check, 3 resistant checks for respective pests (IS 18551, IS 205, ICSV 745), two susceptible checks (DJ 6514, Swarna) were evaluated across the zones at six locations (Coimbatore, Udaipur, Hisar, Dharwad, Akola and Surat) for resistance to key pests mainly shoot fly and stem borer.

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly was recorded peak stage at five locations (Akola, Udaipur, Coimbatore, Surat and Dharwad). At Coimbatore, the data on shoot fly damage was not significant at 5% level and had low percent deadhearts in susceptible check. At Akola, the lowest deadhearts recorded in CSH 20MF and was on par with resistant check IS 18551. At Udaipur, the shoot fly deadhearts was from 47.6 to 81.0 % with an average of 60.8%. All most test entries were on par with resistant checks. The resistant check IS 18551 recorded 47.6%. At Surat, the shoot fly damage at peak stage was from 31.6 to 81.0% being an average of 49.5%. While at Dharwad, the range was from 46.4 to 98.9% with an average of 86.3%. None of the entries were found superior than resistant check (Table 5.1)

Across the locations and genotypes, the overall mean of shoot fly damage at peak stage was from 41.0 to 83.5% being an average of 60.9%. The data was statistically significant at 5% level. The entries SPH 1695, and CSH 24MF recorded lowest deadhearts % and was on par with resistant check IS 18551 at peak stage (Table 5.1).

**Oviposition preference:** The data on eggs per five plants (no) laid due to shoot fly was recorded at two locations viz., Udaipur and Dharwad. At both the places, the CV% was high (>25%). Across the locations, the range was 3.33 to 7.00 eggs/5 pts averaging 5.15 eggs/5 plants. The data was significant at 5% level. The lowest eggs were recorded in SPH 1697, SPH 1698, SPH 1748, SPH 1751, SPH 1752, SPH 1753, CSH 20MF, CSH 24MF and local check at respective centers (<5.53 eggs/5 plants). These entries were varied from resistant check IS 18551 which recorded 4.17 eggs/5 plants (Table 5.1).

**Morpho-physiological traits:** The morpho-physiological traits such as seedling vigor and leaf glossiness were recorded in the scale of 1-5. Leaf glossiness was recorded at Akola and Dharwad during Kharif 2013. There was no significant differences for glossiness among the test entries. Across the locations, the range was from 1.83 to 4.83 with an average of 3.70. The entry SPV 2242 recorded highest leaf glossiness (Table 5.1). The data on seedling vigor was recorded at Udaipur, Surat and Dharwad. The data at Udaipur was not significant at 5% level. Looking across the locations, the range was from 2.44 to 4.44 with an average of 3.70. The entries SPH 1696, SPV 2242, CSH 20MF and Local check were recorded seedling vigor <3.6 and was on par with resistant check IS 18551 (Table 5.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was assessed in terms of leaf injury rating (1-9) at 30 DAE deadhearts (%) at 45 DAE and stem tunneling (%). The data on injury rating (1-9) was recorded at Akola, Coimbatore and Surat. Across the locations, the data on leaf damage rating ranged from 3.00 to 5.22 averaging 4.37. The entries SPH 1700, SPH 1748, SPV 2242, SSG 59-3, and CSH 20MF recorded low leaf injury rating and was on par with resistant check IS 2205 (Table 5.2)

The data on deadhearts at 45 DAE was recorded at Coimbatore, Hisar and Surat. The data at Coimbatore and Surat has high CV%. At Hisar, the data on deadheart% was significant. The range was from 11.1 to 44.3% with an average of 29.1%. None of the genotypes was better than resistant check IS 2205. Across the locations, the data was significant at 5%, however, the data recorded high CV% (>25%). Across the locations and genotypes, the deadhearts percent ranged from 8.0 to 28.8% being an average of 16.6%. The entries that recorded low deadhearts (<10%) are SPH 1695, SPH 1698, SPH 1752, SPH 1753, SPV 2242, SSG 59-3, CSH 20MF and local check recorded lowest deadhearts due to stem borer and were on par with resistant check IS 2205 (Table 5.2).

The data on stem tunneling (%) due to stem borer was recorded at Coimbatore only. The CV% was very high (>25%) and the data was not statistically significant at 5%. The stem tunneling damage was ranged from 4.3 to 71.1 averaging 26.1%. The lowest stem tunneling (%) was recorded in SPV 2242 (Table 5.2).

**Midge (*Stenodiplosis sorghicola* Coq):** There was no recordable damage due to midge at AICSIP center during Kharif 2013.

**Head bug (*Calocoris angustatus*):** The damage due to head bug was not recorded at AICSIP centers.

**Shoot bug (*Peregrinus maidis*):** There was no recordable damage due to shoot bug at AICSIP centers.

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on mite damage rating was recorded in the scale of 1-9 at 75 DAE in Surat. The damage was ranging from 1.00 to 7.67 with an average of 1.85. The data was statistically significant at 5% level. The entries SPH 1715, SPH 1753, SPV 2242, CSH 20MF and CSH 24MF recorded lowest damage 1.0 (5.1). However the CV% was 30.9% (Table 5.1).

**Days to 50 % flowering:** The data on days to 50% flowering were recorded at Surat only. The range was from 77.0 to 90.0 with an average of 80.09 days to flower. The test entries that recorded early flowering (<80 days) was SSPH 1748 (77 days) and the most delayed flowering was noticed in SPV 2242 (Table 5.2).

**Plant population per plot (2.4 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at five centers Akola, Dharwad, Coimbatore, Surat and Udaipur. The CV was very high (>25%) at Udaipur and Coimbatore as results it was reflected on pest incidence especially for shoot fly. The data of plant stand at these centers was not statistically significant. Across the locations, the data on plant stand was ranged from 18.5 to 30.9 plants plot<sup>-1</sup> with an average of 24.2 plant plot<sup>-1</sup> (Table 5.2).

**Grain yield & its components:** Grain yield in grams per five plants was assessed at Surat only. The data on yield was ranged from 178 to 268 g 5 plants<sup>-1</sup> and the mean grain yield was 207 g 5 plants<sup>-1</sup>. It was surprising to note that the susceptible entries Swarna and DJ 6514 recorded higher grain yield (>250 g 5 plants<sup>-1</sup>) (Table 5.2).

#### **Trial 6: Advanced Varietal Trial (AVT-Single-cut) (Locations: 6)**

The trial AVT-SC consisted of total fifteen entries of which seven varieties, two commercial checks (HC 308, CSV 21F), three resistant checks (IS 18551, IS 2205, ICSV 745), two susceptible checks (DJ 6514, Swarna) and one local check from respective locations were evaluated across the zones at six locations (Coimbatore, Udaipur, Hisar, Dharwad, Akola and Surat) for resistance to key pests mainly shoot fly and stem borer.

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly was recorded peak stage at five locations (Akola, Udaipur, Coimbatore, Surat and Dharwad). At Coimbatore, the data on shoot fly damage was not significant at 5% level and had low percent deadhearts in susceptible check. At Akola, none of the test entries were on par with resistant check. However, the lowest deadhearts recorded in CSV 21F. At Udaipur, the shoot fly deadhearts was from 35.4.6 to 82.5 % with an average of 50.5%. The entries SPV 2128, SPV 2211, SPV 2185, SPV 2186 and SPV 2191 recorded up to 46 % deadhearts. These test entries were not different from resistant check. At Surat, the deadheart% range was from 22.2 to 85.3% with an average of 43.4%. The entries, SPV 2186, CSV 21F, SPV 2190, SPV 2191, HC 308 and local check recorded lowest deadhearts% and were on par with resistant check. At Dharwad, the shoot fly damage at peak stage was from 47.1 to 93.4% being an average of 69.7%. None of the entries except CSV 21F, ICSV 745 and local check found superior than resistant check (Table 6.1)

Across the locations and genotypes, the overall mean of shoot fly damage at peak stage was from 39.3 to 85.8% being an average of 58.5%. The data was statistically significant at 5% level. The entries SPV 2186, CSV 21F, SPV 2191, HC 308 and local check recorded lowest deadhearts % and was on par with resistant check IS 18551 at peak stage (Table 6.1).

**Oviposition preference:** The data on eggs per five plants (no) laid due to shoot fly was recorded at two locations viz., Udaipur and Dharwad. At Dharwad, the CV% was high (>25%). Across the locations, the range

was from 4.00 to 6.00 eggs/5 plants averaging 4.88 eggs/5 plants. The data was significant at 5% level. The lowest eggs were recorded in SPV 2211, CSV 21F, SPV 2186, HC 308, ICSV 745 and local check at respective centers (<5.00 eggs/5 plants). These entries were on par with resistant check IS 18551 which recorded 4.50 eggs/5 plants (Table 6.1).

**Morpho-physiological traits:** The morpho-physiological traits such as seedling vigor and leaf glossiness were recorded at 12 days after emergence. The data on glossiness was recorded at Akola and Dharwad. Overall the range was from 2.00 to 4.50 with an average of 3.81. There were no significant differences for leaf glossiness. None of the entries found better than resistant check. The seedling vigor was recorded at Udaipur, Surat and Dharwad. At Udaipur, the data on vigor was not significant at 5% level. Across the locations and genotypes, the data on vigor was statistically significant at 5%. The range was recorded from 2.11 to 4.11 with an average of 3.20. The test entry SPV 2211 recorded highest vigor and was on par with resistant check IS 18551 (Table 6.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was assessed in terms of leaf injury rating (1-9) at 30 DAE, deadhearts (%) at 45 DAE and stem tunneling (%). The data on injury rating (1-9) was recorded at Akola, Coimbatore and Surat. At Coimbatore, the data on leaf damage was significant. It was ranged from 3.00 – 6.67 with a mean of 5.22. At Akola and Surat the data had high CV% and therefore rejected. Across the locations, the data on leaf damage rating was not significant and ranged from 3.3-5.78 being an average of 4.13 in the scale of 1-9. All test entries were on par with resistant check except SPV 2190 (Table 6.2).

The data on stem tunneling (%) due to stem borer was recorded at Coimbatore only. The CV% was very high (>25%) and the data was not statistically not significant at 5%. The stem tunneling damage was ranged from 7.7 to 35.6 averaging 20.0%. The lowest stem tunneling (%) was recorded in SPV 185 (Table 6.2). The data on deadhearts at 45 DAE was recorded at Coimbatore, Hisar and Surat. The data at Coimbatore had high CV%. Across the locations, the deadheart percent range was from 9.3 to 25.5 being an average of 18.3%. The data was significant at 5%. The entry CSV 21F, SPV 2191 and ICSV 745 recorded lowest deadhearts and were on par with resistant check IS 2205 (Table 6.2).

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on mite damage rating was recorded in the scale of 1-9 at 75 DAE at Surat. The damage was ranging from 1.00 to 8.00 with an average of 2.64. The data was statistically significant at 0.05. The entries SPV 2185, CSV 21F, HC 308, Swarna, and DJ 6514 recorded lowest damage (~1.7) (Table 6.2).

**Days to 50 % flowering:** The data on days to 50% flowering were recorded at Surat only. The range was from 78 to 88 with an average of 82.22 days to flower. The test entries that recorded early flowering (<80 days) was SPV 2128 SPV 2185, SPV 2186 and SPV 2191. The most delayed flowering was noticed in SPV 2211 (Table 6.3).

**Plant population per plot (2.4 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at five centers Akola, Dharwad, Coimbatore, Surat and Udaipur. The CV was high (>25%) at Udaipur and Coimbatore as results it was reflected on pest incidence especially for shoot fly. The data of plant stand at these centers was not statistically significant. Across the locations, the data on plant stand was ranged from 19.6 to 25.1 plants plot<sup>-1</sup> with an average of 22.6 plant plot<sup>-1</sup> (Table 6.3).

**Grain yield & its components:** Grain yield in grams per five plants was assessed at Surat only. The data on yield was ranged from 197 to 318 g 5 plants<sup>-1</sup> and the mean grain yield was 237 g 5 plants<sup>-1</sup>. It was surprising to note that the susceptible entries Swarna and DJ 6514 recorded higher grain yield (>300 g 5 plants<sup>-1</sup>) (Table 6.2).

#### **Trial 7: Initial Varietal and Hybrid Trial (IVHT-Forage-Single cut) (Locations: 6)**

The trial IVHT-SC consisted of total twenty one entries of which ten varieties, two hybrids, three commercial checks (HC 308, CSV 21F, CSH 27), three resistant checks (IS 18551, IS 2205, ICSV 745), two susceptible checks (DJ 6514, Swarna) and one local check from respective locations were evaluated at six locations (Udaipur, Hisar, Coimbatore, Dharwad, Akola and Surat) 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 peak period in five centers viz., Akola, Udaipur, Coimbatore, Surat and Dharwad. The data at Coimbatore was rejected due low deadhearts % in susceptible check (<70%), non-significant data, and high CV%. At Akola, the range of shoot fly deadhearts was from 24.9 to 75.6% with an average of 46.9%. The entries SPV 2263, SPV 2264, SPV 2265, SPV 2266, SPH 1752 and HC 308 recorded low deadhearts% and was on par with resistant check. At Udaipur, the range was 38.2-79.6% with an average of 58.2%. The lowest deadhearts due to shoot fly was recorded in SPV 2261, SPV 2265, SPV 2266, SPH 1752, and CSH 27 at Udaipur. The lowest deadhearts % was recorded in SPV 2260, SPV 2262, SPV 2263, SPV 2264, SPV 2265, SPV 2266, SPH 1752 and CSV 21F at Surat. The range was 24.1 to 92.1% with an average of 48.9%. While at Dharwad, it was ranged from 47.1 to 96.3% with an average of 80.3%. The lowest deadhearts recorded at Dharwad in SPV 2258, SPV 2260, SPV 2263, SPV 2265, SPV 2266 and SPH 1752 and were on par with resistant check IS 18551 (37.5% DH) (Table 7.1).

Across the locations and genotypes, the shoot fly damage at peak stage was from 34.8 to 85.7% being an average of 58.6%. The data was statistically significant at 5% level. The entries SPV 2258, SPV 2265 and SPV 2266 recorded lowest deadhearts (< 51%) and were on par with resistant check IS 18551 (34.8%), (Table 7.1).

**Oviposition preference:** The data on eggs per five plants (no) laid due to shoot fly was recorded at two locations viz., Udaipur and Dharwad. The data on eggs at Udaipur was non-significant. At Dharwad, the range was from 2.33 to 13.33 eggs/5 pts averaging 5.33 eggs/5 plants. Across the locations, data was not significant at 5% level. None of the entries were recorded low on par with IS 18551. The lowest eggs were recorded in SPV 2261 (4.33 eggs/5 plants) (Table 7.1).

**Morpho-physiological traits:** The morpho-physiological traits such as seedling vigor and leaf glossiness were recorded at 12 days after emergence. The data on glossiness was recorded at Akola and Dharwad. Overall the range was from 1.67 to 4.67 with an average of 3.83. The data was significant at 5% level. None of the entries were recorded on par with IS 18551. The highest glossiness were recorded in CSV 21F (3.33). The seedling vigor was recorded at Udaipur, Surat and Indore. The data on vigor was significant at 5% level at three locations. Across the locations and genotypes, the data on vigor was statistically significant at 5%. The range was recorded from 1.89 to 4.22 with an average of 3.22. The entries SPV 2257, SPV 2263, SPV 2264, HC 308 and local check recorded highest vigor and was on par with resistant check IS 18551 (Table 7.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was assessed in terms of leaf injury rating (1-9) at 30 DAE, deadhearts (%) at 45 DAE and stem tunneling (%). The data on injury rating (1-9) was recorded at Akola, Coimbatore and Surat. At Akola, the data was significant at 5%. The leaf damage rating ranged from 2.00 to 4.67 with an average of 3.25. At Coimbatore, the data on leaf damage was significant and it ranged from 3.67 – 7.00 with a mean of 5.52. At Surat the data had high CV% and therefore rejected. Across the locations, the data on leaf damage rating was not significant and ranged from 3.56 5.44 being an average of 4.57 in the scale of 1-9. The lowest leaf injury was recorded in local check (Table 7.2).

The data on stem tunneling (%) due to stem borer was recorded at Coimbatore only. The CV% was very high (>25%) and the data was not statistically significant at 5%. The CV % was very high. The stem tunneling damage was ranged from 4.6 to 59.3 averaging 23.0%. The lowest stem tunneling (%) was recorded in SPV 2242 (Table 7.2).

The data on deadhearts at 45 DAE was recorded at Coimbatore, Hisar and Surat. The data at Coimbatore and Surat had high CV%. Therefore it was rejected. At Hisar, the deadheart% range was 11.3 to 47.3 with an average of 31.5. None of the test entries were found superior to resistant check IS 2205. Across the locations, the deadheart percent range was from 8.5 to 37.4 being an average of 37.4%. The data was significant at 5 % level. None of the entries found superior to resistant check. Among the test entries, SPV 2258 recorded lowest deadhearts due to stem borer (18.13%), (Table 7.2).

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on mite damage rating was recorded in the scale of 1-9 at 75 DAE at Surat. The damage was ranging from 1.00 to 8.00 with an average of 2.13. The data was statistically significant at 0.05. However, the data had high CV%. The entries SPV 2257, local check and DJ 6514 recorded lowest damage (1.00) (Table 7.2).

**Head bug (*Calocoris angustatus*):** The damage due to head bug was not recorded at AICSIP centers.

**Shoot bug (*Peregrinus maidis*):** The data on damage rating (1-9) due to shoot bug at 75 DAE did not recorded.

**Midge (*Stenodiplosis sorghicola* Coq):** The data on spike let damage rating (1-9) due to midge did 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. The range was from 76.3 to 86.3 with an average of 83.1 days to flower. The test entries that recorded early flowering (<80 days) was CSH 27. The most delayed flowering was noticed in SPV 2264 (Table 7.3).

**Plant population per plot (2.4 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at five centers Akola, Dharwad, Coimbatore, Surat and Udaipur. The CV was high (>25%) at Udaipur and Coimbatore as results it was reflected on pest incidence especially for shoot fly. The data of plant stand at these centers was not statistically significant. Across the locations, the data on plant stand was ranged from 18.4 to 27.3 plants plot<sup>-1</sup> with an average of 23.8 plant plot<sup>-1</sup> (Table 7.3).

**Grain yield & its components:** Grain yield in grams per five plants was assessed at Surat only. The data on yield was ranged from 190 to 303 g 5 plants<sup>-1</sup> and the mean grain yield was 237 g 5 plants<sup>-1</sup>. It was surprising to note that the susceptible entries Swarna recorded higher grain yield (>300 g 5 plants<sup>-1</sup>) (Table 7.3).

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

A trial was constituted on evaluation of sweet sorghum lines comprising varieties and hybrids for main shoot pests especially for shoot fly under artificial conditions at seven locations (Dharwad, Palem, Rahuri, Akola, Surat, Hisar and Udaipur).

##### **Trial 8: Initial Advanced Varietal and Hybrid Trial (IAVHT-SS) (Locations: 7)**

A sweet sorghum trial (IAVHT-SS) 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 seven locations (Dharwad, Palem, Rahuri, Akola, Surat, Hisar and Udaipur). The trial consisted of total three test hybrids, fourteen varieties, three resistant checks (IS 18551, IS 2205, ICSV 745), two susceptible checks (Swarna, DJ 6514) and three released checks (CSH 22SS, CSV 24SS, CSV 19SS) were evaluated at six locations. No local check was incorporated. 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 peak period in six centers viz., Akola, Rahuri, Udaipur, Coimbatore, Surat and Dharwad. The data at Coimbatore and Udaipur was rejected due low deadhearts % in susceptible check (<70%), non-significant data, and high CV%. At Akola, the range of shoot fly deadhearts was from 42.5 to 89.5% with an average of 65.7. The entry SPV 2270 recorded low deadhearts % and was on par with resistant check. At Rahuri, the range was 34.4-81.1 % with an average of 63.5 %. The lowest deadhearts due to shoot fly was recorded in SPV 2195 and SPV 2205. At Surat, the range was from 34.1 to 87.1 % with an average of 49.7%. The lowest deadhearts % was recorded in SPV 1738, SPV 1739, SPV 2195, SPV 2196, SPV 2269, SPV 2270, SPV 2272, SPH 1755 and CSV 24SS and CSV 19SS. While at Dharwad, it was ranged from 49.6 to 93.7% with an average of 74.5%. The lowest deadhearts % was recorded in SPH 1738 and SPV 2268 and were at par with resistant check IS 18551. Across the locations and genotypes, the shoot fly damage at peak stage was ranged from 41.1 to 84.8% with an average of 63.3%. None of the test entries were superior or at par with resistant check IS 18551 (Table 8).

**Oviposition preference:** The data on eggs per five plants (no) laid due to shoot fly was recorded at three locations viz., Rahuri, Udaipur and Dharwad. The data on eggs was rejected at Udaipur and Dharwad due to non-significant and high CV%. At Rahuri, the range was from 5.00 to 15.67 eggs/5 pts averaging 6.53 eggs/5 plants. None of the test entries was superior or on par with resistant check. Across the locations, data was significant at 5% level. The entries SPV 2201, SPV 2267, SPV 2268, SPV 2271, SPV 2272, recorded up to 4 eggs on 5 plants and were recorded low on par with IS 18551 (Table 8.1).

**Morpho-physiological traits:** The morpho-physiological traits such as seedling vigor and leaf glossiness were recorded at 12 days after emergence. The data on glossiness was recorded at Akola, Rahuri, and Dharwad. Overall the range was from 2.22 to 4.22 with an average of 3.40. The data was significant at 5% level. The entries SPH 1755 and CSV 19 SS recorded highest leaf glossiness and were on par with resistant check. The seedling vigor was recorded at Rahuri, Udaipur, Surat and Dharwad. Across the locations and genotypes, the data on vigor was statistically significant at 5%. The range was recorded from 2.58 to 3.83 with an average of 3.30. The entries SPV 2267, SPV 2268 and SPV 2195 recorded highest vigor and were on par with resistant check IS 18551 (Table 8.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was assessed in terms of leaf injury rating (1-9) at 30 DAE, deadhearts (%) at 45 DAE and stem tunneling (%). The data on injury rating (1-9) was recorded at Akola, Rahuri, Coimbatore and Surat. At Akola, Rahuri and Surat, the data on leaf injury had high CV% and therefore rejected. At Coimbatore, the data on leaf damage was significant. It was ranged from 2.67-7.00 with a mean of 5.59. Across the locations, the data on leaf damage rating was not significant and ranged from 3.42- 5.67 being an average of 4.31 in the scale of 1-9. All test entries were on par with resistant check except SPV 2272. The lowest leaf injury was recorded in test entry SPH 1739 (Table 8.2).

The data on stem tunneling (%) due to stem borer was recorded at Coimbatore only. The CV% was very high (>25%) and the data was not statistically significant at 5%. The stem tunneling damage was ranged from 5.3 to 55.0 averaging 23.0%. The lowest stem tunneling (%) was recorded in SPH 1739 (Table 8.2).

The data on deadhearts at 45 DAE was recorded at Coimbatore, Rahuri, Surat, and Hisar. The data at Coimbatore, Rahuri and Surat had high CV%, whereas the data at Surat was not statistically significant at 5% level. At Hisar, the data ranged from 7.7 to 33.7 with a mean of 28.6%. None of the test entries were recorded either superior or on par with resistant check, IS 2205. Across the locations, the deadheart percent ranged from 8.9 to 21.3 being an average of 15.6%. However, the data was not significant at 5 % level. The entries CSV 19SS recorded lowest deadheart% (Table 8.2).

**Head bug (*Calocoris angustatus*):** The damage due to head bug was not recorded at AICSIP centers.

**Shoot bug (*Peregrinus maidis*):** The data on damage rating (1-9) due to shoot bug at 75 DAE did not recorded.

**Midge (*Stenodiplosis sorghicola* Coq):** The data on spike let damage rating (1-9) due to midge did not recorded at any one of the centers mentioned above.

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on leaf damage rating (1-9) was recorded at Surat centre only. Although the data was significant at 5% level but had high CV %. The data on damage rating ranged from 1.00 to 8.00 with an average of 1.81 in the scale of 1-9. The entries that had 1 damage rating due to spider mite are SPV 2196, SPV 2205, SPV 2267, SPV 2269, SPV 2270, SPH 1755 CSV 24SS and CSH 22SS (Table 8.2).

**Days to 50 % flowering:** The data on days to 50% flowering were recorded at Surat only. The range was from 81.3 to 91.0 with an average of 86.1 days to flower. The test entries that recorded early flowering (81 days) were SPH 1755. The most delayed flowering was noticed in CSV 24SS (91 days) (Table 8.3).

**Plant population per plot (2.4 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at six centers Akola, Dharwad, Rahuri, Coimbatore, Surat and Udaipur. The data on grain yield was not significant at Udaipur and Coimbatore and had high CV and as a result, it was reflected on pest incidence especially for shoot fly. Across the locations, the data on plant stand was ranged from 12.4 to 24.0 plants plot<sup>-1</sup> with an average of 20.2 plant plot<sup>-1</sup> (Table 8.3).

**Grain yield & its components:** Grain yield in grams per five plants was assessed at Surat only. The data on yield was ranged from 195 to 335 g 5 plants<sup>-1</sup> and the mean grain yield was 262 g 5 plants<sup>-1</sup>. The highest grain yield was recorded in SPH 1754 (335 g) (Table 8.3).

## V. Evaluation of selected lines from AICSIP for shoot pest resistance

One trial comprised of forty varieties selected from AICSIP for evaluating against shoot pests. The trial was formulated with an objective to identify breeding sources from AICSIP program which has performed better against shoot pest but neglected due to poor yields. Such lines may find useful sources for shoot pests resistance.

### **Trial 9: Evaluation of AICSIP lines for shoot pest resistance (AICSIP-SPN) (Locations: 3)**

Total forty entries consisted 31 test varieties selected from AICSIP, two released checks (CSV 17, CSV 19 SS), Three resistant sources (IS 18551, IS 2205, RSSV 9), four susceptible checks (SSV 84, 296 B, Swarna, DJ 6514). No local check was incorporated. The trial was conducted at three locations (Akola, Hyderabad and Parbhani).

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly was recorded at peak stage at three locations (Akola, Hyderabad, and Parbhani) (Table 9). At Akola, the damage range was from 24.7-74.2 with an average of 46.5%. At Hyderabad, the range was 38.4-83.9 averaging 62.3%, while at Parbhani; it was 50.2-86.5% with a trial mean of 71.7%. Overall, the data was significant at 5% level. Across the locations, the mean damage was 60.1% ranging from 39.4-80.7%. The entries SPV 2196, SPV 2203, SPV 2204 and RSSV 9 recorded lowest deadhearts and were on par with resistant check IS 18551 (Table 9).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was assessed in terms of leaf injury rating at 30 DAE (1-9) and deadhearts (%) at 45 DAE. The data on deadhearts caused due to stem borer recorded at 45 DAE was recorded at Parbhani. The data was significant at 5% level. The mean deadheart was 6.7%, ranging 3.5-11.1%. The promising entries SPV 2114, SPV 2122, SPV 2057, SPV 2127, SPV 2130, SPV 2131, PV 2132, SPV 2186, SPV 2197 and PV 2198 recorded about 5% deadhearts and were on par with resistant check IS 2205 (Table 9). The data on leaf injury rating (1-9) was recorded at Akola. However, the data on leaf injury rating was not significant and ranged was from 1.33-3.33 being an average of 2.56 in the scale of 1-9. The entry SPV 2197 recorded lowest leaf damage (3.67) (Table 9).

**Plant stand per plot (1.2 m<sup>2</sup>):** The data on plant population per plot of 1.2 m<sup>2</sup> was recorded at three locations; Akola, Hyderabad and Parbhani. The germination was about 80-90%. The overall plant population ranged from 15.2-29.9 with a mean of 22.7 plants per plot across the locations (Table 9).

**Days to 50 % flowering:** The data on days to 50% flowering were recorded at Parbhani. Across the locations, the range was from 74.7-93.0 with an average of 82.6 days to flower. Overall the data was significant at 5% level. The test entry SPV 2197 recorded early flowering (74.7 days) and DJ 6514 recorded longest to flowering days (93 days) (Table 9).

## VI. Screening of initial and advance material for resistant to specific pest

Total four trials consisted of 156 entries including resistant check IS 18551 and Susceptible check Swarna. The lines which have been derived from Institute crossing program, germplasm and some from AICSIP program have been evaluated in three replications mostly for shoot fly and stem borer resistance.

### **Trial 10: Testing of dual purpose sorghum for shoot fly resistance (Elite DP-SF) (Locations: 3)**

The trial was conducted at three locations, Coimbatore, Hyderabad, and Akola. Thirty five entries (11 lines from North plain, seven germplasm unit, DSR, seven from ICRISAT, one from Akola, one from Rahuri, two from Udaipur, three resistant checks, two susceptible and one local check) were evaluated for resistance mainly to shoot fly.

**Shoot fly (*Atherigona soccata*, Rond):** The data on shoot fly deadhearts at peak stage was recorded at Hyderabad, Akola and Udaipur. All the data recorded on shoot fly deadhearts were statistically significant at 5% level. At Hyderabad, the deadhearts range was from 38.9-87.1 % being an average of 51.4%. The test entries that recorded lower deadheart % are: P 23, EC 15, P 45, LDR 238, PGN 39, RSV 9, POP 52, EP 96, SUENT 13, SUENT 9, ICSB 411, ICSV 705, ICSV 93046 and AKR 354. These entries recorded < 49 % DH which is on par

with resistant check (Table 9.1). At Akola, the mean damage was recorded from 21.0-70.9 with a mean of 32.4%. The entries that recorded relatively low deadhearts are EC 15, LDR 238, PFGS 23, PGN 30, PGN 4 RED, Satpani, POP 52, SUENT 13, ICSB 411, ICSB 25019, ICSB 25022, ICSB 25026, and ICSV 93046. These entries were on par with resistant check. At Coimbatore, the deadheart range was from 21.3-79.0 averaging 36.0%. All most all entries recorded low deadhearts except P 23, Lawa, PGN 39, PGN 4 RED, RSSV 9, Satpani, SUENT 13, EC 15, ICSV 705, and IS 4146. These entries are on par with resistant check (Table 10).

Across the locations, the damage range was from 28.8-79.0% with mean of 39.9.1%. Total 10 entries LDR 238, PGN 39, RSSV 9, SUENT 13, EC 15, ICSB 411, ICSV 705, ICSV 93046, IS 2123, IS 2146 were on par with resistant check IS 18551. The resistant check recorded 28.8 % DH at peak stage (Table10).

**Morpho-physiological traits and ovipositional preference:** Morpho-physiological traits such as seedling vigor were recorded at Akola and Hyderabad. The data on seedling glossiness rating (1-9) was significant at 5% level. The data on seedling glossiness recorded low (rating < 3) in RSSV 9, SUENT 13 and, IS 2146 and on par with resistant check IS 18551. Whereas, the data on seedling vigor were recorded lower (< 3) in Lawa, PGN 61, Satpani and IS 2146. Across the locations, IS 2146 recorded high glossiness and more seedling vigor (Table 10).

**Plant stand per plot (1.2 m<sup>2</sup>):** The data on plant population per plot of 1.2 m<sup>2</sup> was recorded at three locations Hyderabad, Udaipur and Coimbatore. The germination was about 80-90%. The overall plant population ranged from 14.6-33.6 with a mean of 27.7 plants per plot across the locations. The data was not significant looking to overall data (Table 10).

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

The data on injury rating was recorded at Coimbatore, Akola and Hyderabad. Across the locations, the range was from 3.22-4.56 being an average of 3.91 in the scale of 1-9. The entries that recorded low damage rating (< 3.5 ) are Lawa, P 23, P 45, LDR 238, PFGS 23, PGN 30, PGN 39, PGN 4 RED, PGN 61, RSSV 9, Satpani, SUENT 13, EC 15, POP 52, EP 96, ICSV 93646 and IS 2123. The data was on par with IS 2205 (Table 10).

The data on deadhearts % at 45 DAE was recorded at three locations (Coimbatore, Hyderabad, and Hisar). The data recorded at all locations were significant at 0.05. At Coimbatore, the entries LDR 238, PGN 30, PGN 39, PGN 4 RED, AKR 254, ICSV 25022, and ICSV 25026 recorded <15% deadhearts. The range was 9.8-28.5 with an average of 18.4. At Hisar, the range was 15.7- 47.3 with an average of 28.9%. The entries PGN 111 and ICSV 93046 recorded lowest damage. At Hyderabad the mean range was from 11.1 to 46.5% with an average of 19.2%. The entries P 23, P 45, PGN 30, PGN 39, PGN 61, RSSV 9, Satpani, PGN 111, EC 15, EP 96, ICSV 93046 and IS 2123 recorded low deadhearts due to stem borer. Across the locations, the range was 13.3-40.6% averaging 22.2%. The data was significant at 5% level. The entries that recorded lowest (<21%) deadhearts are: P 45, PGN 30, PGN 39, RSSV 9, Satpani, AKR 354, PGN 111, EC 15, POP 52, ICSV 93646 and IS 2123 (Table 10).

**Overall resistant rating:** The data on overall rating on resistance was recorded at Hyderabad and was significant at 5 % level. The range was from 4.00 -7.0 averaging of 5.3. The entries that showed high resistant (up to 5 rating) are P 23, PGN 4RED, RSSV 9, SUENT 13, AKR 354, IEC 15, ICSV 12001, ICSV 25022, ICSV 93646 and IS 2146 (Table 10).

#### **Trial 11: Testing of DSR's (F<sub>8</sub> & F<sub>9</sub>) selections for key pest resistance (DSR-SPRN) (Locations: 5)**

The trial was conducted at five locations; Akola, Coimbatore, Hyderabad, Palem, and Parbhani for shoot fly resistance evaluation and Palem, Hyderabad and Coimbatore for stem borer. Forty five entries (26 F<sub>8</sub> & F<sub>9</sub> crosses from DSR, 15 parents, two resistant and two susceptible checks) were evaluated for resistance mainly to shoot fly and stem borer.

**Shoot fly (*Atherigona soccata*, Rond):** The data on shoot fly deadhearts at peak stage was recorded at Akola, Coimbatore, Hyderabad, Palem, and Parbhani. All the data recorded on shoot fly deadhearts were statistically significant at 5%. At Akola, the range of shoot fly deadhearts was from 39.1-84.5 with a mean of 58.4%. At Coimbatore, the deadhearts range was 24.8-76.7 with an average of 40.0%. At Hyderabad, the deadhearts range was from 37.7 to 93.0% being an average of 54.1%. At Palem, the deadhearts range was 41.6-90.6% with

an average of 65.0%, while at Parbhani; it was from 49.9 to 94.4% averaging 76.7%. Across the locations, the crosses that recorded lower deadhearts % (M 35-1 x ICSV 714)-3-1-1, (M 35-1 x IS 2312-1)-3-2-2, and (ICSV 700 x ICSV 705)-1-1-1 and were on par with resistant check (Table 11.1)

**Morpho-physiological traits and ovipositional preference:** Morpho-physiological traits such as leaf glossiness were recorded at Akola, Palem, Parbhani and Hyderabad during Kharif 2013. Overall, the data on these traits were significant at 5% level except the data of Akola and Palem. Across the locations the range was 2.63-4.75 with an average of 3.38 in the scale of 1-5. The crosses that recorded high leaf glossiness are (P 23 x ICSV 705)-1-1-5, (EP 60 x IS 18551)-3-1-2), (EC 15 x ICSV 714)-2-1-2, (ICSV 700 x IS 2205-1)-3-1-1, (ICSV 700 x ICSV 705)-1-2-1, (ICSV 700 x ICSV 704)-1-1-2. The seedling vigor was recorded at Hyderabad, Palem and Parbhani. The data at Parbhani was significant at 5% level. The highest vigor was recorded in the crosses are (EC 15 X SUEENT 13)-1-2-1, (ICSV 700 x ICSV 705)-1-2-1, (ICSV 700 x ICSV 704)-1-1-2 and (ICSV 700 x ICSV 705)-1-2-2 (Table 11.1). The data on oviposition preference (eggs/5 plants) was recorded only at Indore. The data was ranged from 9.0 to 34.0 with an average of 19.7 eggs on 5 plants. Lowest oviposition was recorded in the crosses (C 43 x IS 2312-2)-1-1-4, (ICSV 700 x IS 2205-1)-3-2-4, (EC 15 x SUEENT 13)-1-2-1. However the data was not significant at 5% level (Table 11.1).

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

The data on deadhearts caused due to stem borer recorded at 45 DAE was recorded at four locations (Coimbatore, Hyderabad, Parbhani and Palem). The data recorded at Coimbatore, Parbhani and Palem was not significant at 5% level. At Hyderabad, the mean range was 11.7 to 48.8 % with a mean of 18.6%. Across the locations, the overall mean DH % due to stem borer at 45 DAE was significant at 5% level. The damage range was from 9.3 to 28.1 with an average of 15%. The most promising crosses that recorded <11% deadhearts are (PGN 35 x PGN 30)-3-2,(EC 15 x ICSV 714)-2-1-2, (ICSV 700 x IS 2205-1)-3-1-2, and (ICSV 700 x ICSV 705)-1-1-1. These lines were on par with resistant check IS 2205 (Table 11.2).

The data on injury rating (1-9) was recorded at Coimbatore, Hyderabad and Akola. The data from Hyderabad was significant at 5% level. Across the locations, the data on leaf injury rating was non-significant. Overall range was from 3.0-5.0 being an average of 3.99 in the scale of 1-9. The crosses that recorded lowest damage rating is (PGN 35 X PGN 30)-3-2-3, (ICSV 700 x IS 2312)-1-2 (Table 11.2).

**Head bug (*Calocoris angustatus*):** The data on panicle damage rating due to head bug (1-9) was recorded at milk stage from Palem and Parbhani. Across, the locations, the damage rating was from 1.0 to 3.0 with an average of 2.0. Very low range was recorded. However the data was not significant at 5% level. The crosses that recorded least damage (rating 1.5) are (EC 60 x IS 18551)-3-1-3, (ICSV 700 x IS 2205-1)-3-1-1, (ICSV 700 x ICSV 705)-1-2-1 and (M-35-1 x IS 2312-1)-3-2-2 (Table 11.2).

**Overall resistant rating:** The data on overall rating on resistance was recorded at Hyderabad, Palem, and Parbhani and was significant at 5 % level at Parbhani only. The range at Parbhani was from 3.00 -8.0 averaging of 6.2. The entries that showed high resistant (up to 5 rating) are (EC 15 x ICSV 714)-2-1-2 and (M-35-1 x ICSV 714)-3-1-1 (Table 11.3).

**Plant stand per plot (1.2 m<sup>2</sup>):** The data on plant population per plot of 1.2 m<sup>2</sup> was recorded at five locations Akola, Hyderabad, Palem, Parbhani and Coimbatore. The overall plant population ranged from 9.2-28.5 with a mean of 21.3 plants per plot across the locations. The data was significant at 5% level (Table 11.3).

#### **Trial 12: Identifying sources from forage locals for shoot fly resistance (Forage-LC-SF) (Locations: 3)**

A forage trial comprising twenty four entries (nineteen local forage checks provided by AICSIP centers, three resistant checks and two susceptible checks) were evaluated for pest resistance at three locations: Akola, Hyderabad and Parbhani.

**Shoot fly (*Atherigona soccata*, Rond):** The data on shoot fly deadhearts at peak stage was recorded at Akola, Hyderabad and Parbhani. All the data at three locations recorded on shoot fly deadhearts were statistically significant at 5%. At Akola, the range of shoot fly deadhearts was from 42.8-91.8 with a mean of 65.0%. At Hyderabad, the deadhearts range was from 39.6 to 88.2% being an average of 53.6%. While at Parbhani; it was from 43.7 to 90.6 averaging 66.8%. Across the locations, the entries that recorded lower percent of deadhearts

are: CO (FS)-29, CSV 21F, Ramkel, Katakhatav, RSSV 9, Rampur local and Sangoli Hundi. These lines are on par with resistant check IS 18551 which recorded 43.0% deadhearts. The range was from 43.0 to 89.4% being an average of 61.8% (Table 12)

**Morpho-physiological traits and ovipositional preference:** Morpho-physiological traits such as leaf glossiness were recorded at 12 days after emergence at Akola, Parbhani and Hyderabad. Overall, the data on the trait was significant at 5% level. Across the locations the range was 2.72 - 4.44 with an average of 3.70 in the scale of 1-5. The entries that recorded high leaf glossiness are: HC 308, Katakhatav, SSG 59-3 and RSSV 9 and were on par with IS 2312. The seedling vigor was recorded at Hyderabad only. The data was significant at 5% level. The highest seedling vigor was recorded in the entries are: HC 308, CFS 5, HC 136, HC 171, Rampur local, SL 44, SSG 74, and SSG 59-3 and were on par with IS 2312 (Table 12).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was assessed in terms of leaf injury rating at 30 DAE (1-9) and deadhearts (%) at 45 DAE. The data on leaf injury rating (1-9) was recorded at Akola and found significant at 5% level. The range was from 2.00-3.67 being an average of 2.60 in the scale of 1-9. The range was very narrow and thus almost all entries except SSV 84, IS 2312, HC 136 and Swarna could show injury rating below 3 (Table 12).

**Plant stand per plot (1.2 m<sup>2</sup>):** The data on plant population per plot of 1.2 m<sup>2</sup> was recorded at three locations Akola, Hyderabad and Parbhani. The overall plant population ranged from 10.9-28.4 with a mean of 19.50 plants per plot across the locations. The data was significant at 5% level (Table 12).

**Days to 50 % flowering:** The data on days to 50% flowering were recorded at Parbhani centre. The range was from 79.0-91.7 with an average of 86.6 days to flower. Overall the data was significant at 5% level. The test entries that recorded early flowering (<80 days) are IS 2205 and IS 18551. The test entries that recorded longer duration to flower (> 90 days) are DJ 6514 and Katakhatav (Table 12).

**Overall resistant rating:** The data on overall rating on resistance was recorded at Parbhani and was significant at 5 % level. The range was from 3.67 - 8.00 averaging of 6.3. The entries that showed high resistant (up to 5 rating) are CO (FS)-29, SSG 59-3, IS 2205 and IS 2312 (Table12).

### **Trial 13: Identification of multi-pest resistance lines Ento-Patho collaboration (PDRN) (Locations: 3)**

A collaborative trial on pest-disease resistant sources comprising twelve entries viz., four grain mold resistance, three shoot pest resistance, one local check (CSV 15) and two checks for grain mold (BS 8586-res, RS, 296B-sus), two checks for shoot fly( IS 18551-res, Swarna-sus) was evaluated for pest resistance at three locations viz, Akola, Dharwad and Hyderabad under artificial conditions.

**Shoot fly (*Atherigona soccata*, Rond):** The data on shoot fly deadhearts at peak stage was recorded at Akola, Hyderabad and Dharwad. All the data at three locations recorded on shoot fly deadhearts were statistically significant at 5%. At Akola, the range of shoot fly deadhearts was from 32.0 to 70.3 with a mean of 46.4%. At Hyderabad, the deadhearts range was from 41.8 to 80.7% being an average of 58.5%. While at Dharwad; it was from 42.9 to 88.0 averaging 60.6%. Across the locations, the range was 40.0 to 79.7 with an average of 55.2%. The entries that recorded lower percent of deadhearts are: NRCS-FR09-3, RSSV 9 and SUENT 13. These lines are on par with resistant check IS 18551 which recorded 43.0% deadhearts (Table 13)

**Morpho-physiological traits and ovipositional preference:** Morpho-physiological traits such as leaf glossiness were recorded at 12 days after emergence at Akola, Dharwad and Hyderabad. Overall, the data on the trait was not significant at 5% level except at Akola. Across the locations the range was 2.8 - 4.4 with an average of 3.8 in the scale of 1-5. The entries that recorded high leaf glossiness (SUENT 13, RSSV 9, NRCS-FR09-3) were although on par with IS 2312, but not significantly different from each other. The seedling vigor was recorded at Dharwad and Hyderabad. The data was not significant at 5% level. Overall, the highest seedling vigor was recorded in SUENT 13 and were on par with IS 2312 (Table 13). The oviposition (shoot fly eggs per 5 plants) at 14 DAE was recorded at Dharwad. The range of oviposition preference across the locations and genotypes were 2.3- 4.0 with an average of 3.28 eggs/5 plants. The entries NRCS-FR09-3, GMR 309, and CSV 15 recorded least oviposition (Table 13).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was assessed in terms of leaf injury rating at 30 DAE and recorded at Akola only. However it was not significant at 5% level. The

range was from 2.30-4.00 being an average of 3.14 in the scale of 1-9. The range was very narrow. The lowest leaf injury was recorded in GMR 144-2 and GMR 156 (2.3 rating) (Table 13).

**Plant stand per plot (1.2 m<sup>2</sup>):** The data on plant population per plot of 1.2 m<sup>2</sup> was recorded at three locations Akola, Hyderabad and Dharwad. The overall plant population ranged from 19.8-25.2 with a mean of 22.9 plants per plot across the locations. The data was not significant at 5% level (Table 13).

**Overall resistant rating:** The data on overall rating on resistance was recorded at Hyderabad and was not significant at 5 % level. The range was from 3.0 - 6.0 averaging of 4.3. The entry GMR 308 recorded highest resistant rating (3.0 rating) (Table13).

## VII. Pest management methods in sorghum

Use of endosulfan on crop has been banned by the National Plant Protection Authority. There is a need to evaluate newer 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 (NSKE @ 5%) and intercropped with red gram or soybean has proved to be cost effective at desirable level of pest management. At RARS, Palem two trials have been conducted, one on evaluation of newer molecules against stem borer and another trial is combined use on insecticides and fungicides for the management of head bug and ergot disease.

### Trial 14: Evaluation of certain foliar sprays against stem borer, RARS, Palem- Kharif 2013-14

A trial on different insecticides using new molecules was conducted against stem borer at RARS, Palem. Total 9 treatments with three replications were applied with a gross plot having size of 3.0mx6.0m=18 sqm. Two sprays of the insecticides were applied at 45 and 55 days after emergence. The data on stem borer deadhearts (%) on 10 days after spray and peduncle damage (%) at harvest were recorded. In addition, fodder and grain yield were also recorded at harvest. Two sprays of Rynaxypyr @ 0.3ml/l reduced the deadhearts damage 6.13% followed by whorl application of carbofuran 3G granules @ 20 kg/ ha and recorded 7.88% deadhearts due to stem borer. Both the treatments were on par with each other. While in control plots 74.48% deadhearts were recorded. Lowest peduncle damage % was in the treatment of Rynaxypyr @ 0.3ml/l and followed by recorded in spary of Thiodicarb @ 1.5 g/l. The highest fodder and grain yield (kg/ha) was recorded in the treatment of Rynaxypyr @ 0.3ml/l (Table 14).

Table 14. Evaluation of newer insecticides for management of stem borer, *C. partellus* at RARS, Palem during Kharif 2013.

S. No.	Treatment	SBDH% 65 DAE	Peduncle damaged Plant (%)	Fodder Yield (kg/ha)	Grain Yield (kg/ha)
T1	Rynaxypyr @ 0.3ml/l	6.13 (16.32)*	4.38 (12.08)*	2283.33	1366.66
T2	Acephate @ 1.5 g/l	13.65 (30.05)	9.85 (18.24)	2120.00	1220.00
T3	Phosphamidon @ 2ml/l	18.06 (34.57)	11.6 (19.89)	2076.66	1183.33
T4	Monocrotophos @ 1.6ml/l	16.48 (33.25)	9.14 (17.56)	2113.33	1203.33
T5	Neem oil @ 5ml/l	21.03 (37.66)	13.43 (21.47)	2003.33	1180.00
T6	Thiodicarb @ 1.5 g/l	8.3 (23.41)	7.3 (15.64)	2166.66	1233.33
T7	Cypermethrin 25 EC @ 5ml/l	17.68 (34.27)	9.67 (18.10)	2010.00	1150.00
T8	Whorl application of carbofuran granules 3 G @ 20 kg/ha	7.88 (21.89)	8.16 (16.56)	2233.33	1300.00
T9	Control	74.48 (75.16)	13.66 (21.66)	1950.00	1120.00
	Mean	27.24	13.80	2106.29	1217.41
	CD (5 %)	6.16	5.18	136.78	48.41
	CV (%)	21.57	18.55	3.75	2.27

\* The figures in parentheses are arc sin transformation.

### Trial 15: Evaluation of pesticides against earhead bug and ergot disease, RARS, Palem- Kh- 2013-14

Another trial on management practices for ear head bug and ergot disease was conducted at RARS farm, Palem during Kharif 2013-14. Total six treatments with three replications were applied with gross plot size of

3.0m x 6.0m = 18 sq.m each. One spray of insecticides/fungicides was applied at earhead formation stage. The observations on number of earhead bugs/panicle, damage rating (1-9), ergot score (1-9) and grain yield at harvest were recorded. In general, the combined application of carbaryl @ 3g/l + carbendazim @ 1g/l was very effective in reducing head bug populations, damage and ergot disease (Table 15). Both the carbendazim and carbaryl found compatibility to each other. The highest grain yield was recorded in carbaryl @ 3g/l + carbendazim @ 1g/l (Table 15).

**Table 15. Evaluation of certain management practices for ear head bug and ergot disease during Kharif 2013-14, RARS, Palem**

S. No	Treatment	Head bugs/panicle (No)	Earhead damage rating (1-9)	Ergot score (1-9)	Grain yield (kg/ha)
1	Seed treatment with thiram @ 3g/kg seed	35.50 (6.04)*	7.25 (2.87)*	6.50 (2.73)*	868.75
2	Carbaryl @ 3g/l	8.25 (3.03)	3.00 (2.00)	2.50 (1.86)	1050.00
3	Carbendazim @ 1g/l	32.50 (5.78)	7.00 (2.82)	2.00 (1.72)	1037.50
4	Carbaryl @ 3g/l + Carbendazim @ 1g/l	7.75 (2.94)	2.50 (1.85)	2.00 (1.72)	1175.00
5	Seed treatment with thiram @ 3g/kg seed + carbaryl @ 3g/l	9.00 (3.15)	2.75 (1.93)	4.25 (2.27)	1006.25
6	Control	38.00 (6.24)	7.50 (2.91)	7.25 (2.87)	856.25
	<b>Mean</b>	<b>4.53</b>	<b>2.39</b>	<b>2.20</b>	<b>998.96</b>
	<b>CD (5 %)</b>	<b>0.32</b>	<b>0.22</b>	<b>0.33</b>	<b>86.21</b>
	<b>CV (%)</b>	<b>4.68</b>	<b>6.28</b>	<b>9.97</b>	<b>5.67</b>

\* The figures in parentheses are arc sin transformation.

## VIII. Annexure- Relevant information on publications, trials conducted, hot spots etc

### Annexure I: DSR-AICSIP Publications in Entomology- 2013

#### National Journals (12)

1. Anandhi, P., L. Saravanan, Elamathi, P.W. Ramtake, S., Savita varma and Sobita Simon, 2013. Native *Bacillus Thuringiensis* Berliner Isolates with A Wide Spectrum of Activities Against Cruciferous Pests From Diverse Habitats Of India. *Biological Agriculture & Horticulture: An International journal for sustainable production systems*, DOI: 10.1080/01448765.2013.827131, Published online on 19 Aug. 2013. (NAAS: 6.8)
2. Bhagwat, VR, Prasad, GS, Prabhakar, Pawar, DB, Biradar, AP, Babu, KS, Subbarayudu, B, and Patil JV 2012. Detection of durable resistance sources and their mechanism of resistance to sugarcane aphid, *M. sacchari* in post-rainy sorghum. *Indian Journal of Agricultural Sciences* (Accepted).
3. Biradar, AP; Bhagwat, VR; Biradar, BD and Balikai, RA 2013. Evaluation of IPM components against key pests of sorghum in northern Karnataka. *Journal of Eco friendly Agriculture*, **9** (1) 33-36.
4. Daware DG; Bhagwat, VR; Ambilwade P.P. and Kamble R. J. 2012. Evaluation of integrated pest management components for the management of sorghum shoot pest in Rabi season. *Indian Journal of Entomology* **74** (1):58-61.
5. Daware, DG; Mehtre, SP; Bhagwat, VR; Ambilwade, PP; Biradar, AP; Dhutmal, RR and More AW 2013. Screening of Marker Assisted Selection (MAS) lines of Sorghum against shoot fly resistance in post rainy season. *Indian Journal of Plant Protection* (Accepted)
6. Kiran Gandhi,B , Shekharappa and Balikai, RA. 2013. Estimation of per cent earhead damage and yield loss due to earhead caterpillar *Helicoverpa armigera* under natural condition on Kharif Sorghum. *International Journal of plant protection*, Hind agri-horticultural society (accepted). [www.hinagrihorticulturalsociety.co.in](http://www.hinagrihorticulturalsociety.co.in).
7. Kiran Gandhi.B, and Shekharappa, 2013, Evaluation of commonness of earhead Caterpillars by changing sowing dates in Kharif /Sorghum. *IOSB Journal of Agriculture and Veterinary Science* (IOSB-JAVS) e-ISSN. 2319-2380, p-ISSN: 2319-2372. Volume X, Issue X (Jan-Feb.2013), [www.josrjournals.org](http://www.josrjournals.org).
8. Matti, PV; Shekharappa, R.A. Balikai,R.R.Patil V.B.Naragund, and V.S.Hegde,2013,Development of prediction models for sorghum shoofly, (*Atherigona socata* Rondani) based on weather parameters. *Journal of Expt. Zool.* **16** (2)445-449
9. Savita Varma, P. Anandhi, Daya Shankar Srivastava, 2013. Biological and predatory efficiency of lady bird beetle, *Coccinella septumpunctata* Linnaeus (Coleoptera: Coccinellidae) on brinjal aphid, *Aphis gossypii* Glover (Homoptera: Aphididae), *Journal of Entomological Research*, **37** (3); 211-214.
10. Sharma, HC, Bhagwat, VR, Daware, DG, Pawar, DB, Munghate, RS, Sharma, SP, Reddy, BVS, Prabhakar, KB, Ambekar, SS and Gadakh SR. 2013. Identification of sorghum genotypes with resistance to the sugarcane aphid *Melanaphis sacchari* under natural and artificial infestation. *Plant Breeding* (doi:10.1111/pbr.12111): 1-9 (NAAS 7.6)
11. Solanki, BG 2013. Sorghum in Gujarat. Training Manual on Sorghum spider mite, *Oligonychus indicus* Hirst. pp. 8-15.
12. Upadhyay, SN and Bhagwat, VR 2012. Eco-friendly management of insect pests of sorghum. *Indian Journal of Applied Entomology* **26** (2): 152-154.

#### Poster/paper presentation in Conference (5)

1. Anandhi, P., V R Bhagwat, S Elamathi, R Sankarapandian and D Jawahar, 2013. Seasonal abundance and population dynamics of major pests in sorghum growing areas of South Tamil Nadu" poster presented "In the International Seminar on Global Consultation on Millets Promotion for Health & Nutritional Security" held on at DSR, Hyderabad, 18-20 December, 2013.
2. Anandhi, P., V R Bhagwat, R Sankarapandian, S Elamathi, and D Jawahar, 2013. "Evaluation and selection of the mite resistant/tolerant varieties in sorghum under Southern region of Tamil Nadu poster presentation "In the International Seminar on Global Consultation on Millets Promotion for Health & Nutritional Security" held on at DSR, Hyderabad, 18-20 December, 2013.
3. G.R.Bhandari, G. G. Radadia and B. G. Solanki (2013). Biology of rice weevil, *Sitophilus oryzae* (Linnaeus) on Stored Sorghum.pp.33-37 Compendium of paper and abstract, Society for millet Research.

(International Seminar on Global Consultation on Millets Promotion for Health & Nutritional Security held at DSR, Hyderabad during 18th to 20th Dec., 2013.)

4. K. A. Patel (2013). Bio-ecology of sorghum spider mite, *Oligonychus indicus* Hirst., and influence of weather parameters. Pp.159-163 Compendium of paper and abstract, Society for millet Research.
5. Solanki, BG, Patel, KA and Bhanderi, GR 2013. Field screening of sorghum genotypes/varieties for their resistance to sorghum stem borer, *Chilo partellus* Swinhoe paper presented as poster in International Seminar on "Global consultation on Millet promotion for health and nutrition security" held during 18-20 Dec. 2013 at DSR, Hyderabad

#### **Books/book chapters/ manuals/bulletin (3)**

1. K.A.Patel, B.G.Solanki, G.R.Bhanderi, V.R.Bhagwat and Abhishek Shukla(2013). Training Manual on Training Manual on Sorghum spider mite, *Oligonychus indicus* Hirst.
2. K.A.Patel and G.R.Bhanderi (2013). Juvar ni jivato- Krushi pako ma sankalit jivat vyavasthapan. pp. 14-16.
3. B.G.Solanki (2013). Sorghum in Gujarat. Training Manual on Sorghum spider mite, *Oligonychus indicus* Hirst. pp. 8-15.

#### **Popular Article (5)**

1. Anandhi, P and Gailce Leo Justin. 2013. "Integrated pest management in sorghum" published in the daily News paper Dinamani on 27.06.2013.
2. Choudhary, RK; Bhagwat, VR; Singh, SB; M.Parmar, Thakur N.S., Kushwaha B.B & Swathi P., (2013) "Management of sorghum pests and their natural enemies through integrated approaches", PP-23,
3. G.R.Bhanderi, K.A.Patel and B.G.Solanki(2013). Juvar na Rogo, Accepted for publication Krushi Go Vidya
4. G.R.Bhanderi, K.A.Patel and B.G.Solanki(2013). Juvar ni Sangrahit Jivato, Accepted for publication Krushi Go Vidya
5. K.A.Patel, G.R.Bhanderi and B.G.Solanki(2013). Juvar ni Jivato, Accepted for publication Krushi Go Vidya

#### **Leaflets/folders (5)**

1. Anandhi, P., Gailce Leo Justin and Sankarapandian, R. 2014. "Insect pest management in Sorghum" published in the Regional Agricultural mela on 02.01.2014 at AC & RI, Killikulam.
2. Anandhi, P., Gailce Leo Justin and Ramalingam, A. 2014. "Integrated pest management in cotton" published in the Regional Agricultural mela on 02.01.2014 at AC & RI, Killikulam.
3. Anandhi, P and Sankarapandian, R. 2014. "Package of practices for summer Sorghum cultivation" published in the summer Sorghum cultivation Farmers workshop on 14.03.2014 at RVS, ICAR, KVK, Oormalalazhian.
4. Patel, KA and Bhanderi, GR 2013. Juvar ni jivato- Krushi pako ma sankalit jivat vyavasthapan. pp. 14-16.
5. 14 different folders regarding sorghum cultivation, plant protection and value addition were published under TSP/FLD programme.

#### **Training organized (1)**

Training on "Sorghum mites" was organized by Main Sorghum Research Station, Surat on 17-18 Oct.2013 under Golden Jubilee celebration of DSR.

#### **Workshops / conference / Seminars/meetings attended (3)**

1. Dr R.K. Choudhary from Indore attended two days training cum seminar on Sorghum mites at NAU, Surat on 17&18 October 2013.
2. Dr.R.K.Choudhary visited Brazil during 1<sup>st</sup> -10<sup>th</sup> February 2014 under JICA Project.
3. The Entomologists from AICSIP centers (Akola, Indore, Surat, Palem, Dharwad, Bijapur, Rahuri and Parbhani participated in the International Seminar on "Global consultation on Millet promotion for health and nutrition security" held during 18-20 Dec. 2013 at DSR, Hyderabad.

#### **Awards / Medals obtained**

1. Dr P Anandhi, ARS, Kovilpatti received as "Life Fellow Award of the Entomological Society of India", New Delhi
2. Dr VR Bhagwat, DSR received as "Life Fellow Award of the Entomological Society of India" New Delhi

**Annexure II: AICSIP Entomology trials and nurseries conducted Kharif 2013**

Trial No	Trials	Ent	Rep	Plot size (rs x m)	Number of trials to be conducted at each AICSIP centre										Total	
					Coi	Dha	Pal	Par	Rah	Ako	Ind	Sur	Uda	Hyd		His
<b>I. Evaluation of AICSIP breeding materials for key pest resistance</b>																
1	AHT (GS)	19	3	2 x 2	1	1	1	1	1	1	2	2	1		11	
2	AVT (GS)	26	3	2 x 2	1	1	1	1	1	1	2	2	1		11	
3	IHT (GS)	13	3	2 x 2	1	1	1	1	1	1	2	2	1		11	
4	IVT (GS)	25	3	2 x 2	1	1	1	1	1	1	2	2	1		11	
5	IAVHT (MC)	22	3	2 x 2	1	1				1		2	1		7	
6	AVT (SC)	15	3	2 x 2	1	1				1		2	1		7	
7	IVT (SC)	21	3	2 x 2	1	1				1		2	1		7	
8	IAVHT (SS)	25	3	2 x 2	1	1			1	1		2	1	1	9	
<b>II. Interdisciplinary program on basic &amp; strategic research for multi-pest resistance/agronomic characters</b>																
9	AICSIP-SPN	40	3	2 x 2	1		1	1		1	1		1	1	7	
10	Elite-DP for SF & SB	35	3	2 x 2	1					1			1	2	6	
11	Forage-SF	24	3	2 x 2				1		1			1	1	4	
12	DSR-SPRN-F <sub>9</sub>	45	2	2 x 2	1		1	1		1				2	6	
13	PDRN*	12	3	2 x 2		1				1			1	1	4	
14	ICRISAT-SPN	20	3	2 x 2		1	1	1	1	1	1	1	1		9	
<b>III. On-farm evaluation of IPM module/public sector trials</b>																
15	On-Farm IPM			Need based IPM at desirable centers (minimum 1 acre for each treatment)												
<b>IV. Pest surveillance, seasonal abundance &amp; population dynamics of sporadic &amp; unusual pest outbreaks</b>																
16	Pest survey			Farmers field	Mandatory for all centre, use Performa											
				Total trials	11	10	7	8	6	14	10	17	13	12	5	113

**Note:** Two plantings of each trial should be followed, where there is incidence of shoot fly and stem borer.

1= Single planting (shoot fly or stem borer), 2 = two plantings (Shoot fly and stem borer)

- The pest specific trials should be planted at appropriate time (Example: Stem borer: early planting, Shoot fly : Late planting)
- A methodology for evaluation and sample format for recording pest surveillance data is on [www.sorghum.res.in](http://www.sorghum.res.in)
- Recording pest and natural enemies status during survey at farmer's field is mandatory. Please use format.
- \* PDRN trial will be planted by Entomologist and Pathologists separately.

### Annexure III: Entomology trials data-Compliance Report -Kharif 2013

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	Mite
1	Coimbatore	11	27-Jul	NS	20 Jan	20 Jan	NR	NR	NR	NR	NR
2	Palem	7	30-June	NS	22 Jan	22 Jan	NR	NR	22 Jan	NR	NR
3	Parbhani	8	17-Jul	NS	31 Dec	31 Dec	NR	NR	NR	NR	NR
4	Akola	14	31-July	NS	01 Jan	NR	NR	NR	NR	NR	NR
5	Dharwad	10	17-Jul	NS	17 Jan	17 Jan	NR	NR	NR	NR	NR
6	Indore	10	22-Jun	11-Jul	30 Jan	30 Jan	NR	NR	30 Jan	NR	NR
7	Surat	17	27-Jun	10-Jul	17 Jan	17 Jan	NR	NR	NR	NR	17 Jan
8	Rahuri	6	5-Jul	NS	30 Jan	NR	NR	NR	NR	NR	NR
9	Udaipur	13	26-Jul	NS	24 Dec	24 Dec	NR	NR	NR	NR	NR
10	Hisar	5	21-Jul	NS	NR	27 Jan	NR	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, Head bug
Surat	Shoot fly, Stem borer, mite
Indore	Shoot fly, Stem borer
Akola	Shoot fly
Bijapur	Stem borer, Aphid, Shoot bug
Rahuri	Shoot fly, Aphid
Hyderabad	Shoot fly, Stem Borer, Shoot bug

### Annexure V: The list of Sorghum Entomologists in AICSIP

No	Name	Brief address	email	Contact No
1	Dr. P Anandhi	SRS, TNAU, Coimbatore SRS, TNAU, Kovilpatti	kovilpatti@sorghum.res.in coimbatore@sorghum.res.in	+918903155400
2	Dr Kavitha	RARS, Palem, ARS, Tandur	palem@sorghum.res.in tandur@sorghum.res.in	+919440651379
3	Dr Shekharappa	ARS, UAS, Dharwad	shekhar1993@yahoo.com	+919449949736
4	Dr AP Biradar	RARS, UAS, Bijapur	bijapur@sorghum.res.in	+919448405933
5	Dr DB Pawar	Sorghum Improvement Project, MPKV, Rahuri	rahuri@sorghum.res.in	+917588028922
6	Dr P. Ambilwade	SRS (AICSIP), MAU, Parbhani	parbhani@sorghum.res.in	+919420886604
7	Dr Sameer Kale	Sorghum Res. Scheme (AICSIP) DSDKV, Akola	akola@sorghum.res.in	+919970070948
8	Dr RK Choudhary	JNKKV, College of Agriculture, Indore	indore@sorghum.res.in	+919425950464
9	Dr KA, Patel	MSRS, NAU, Surat	surat@sorghum.res.in	+919979528606
10	Dr Lekha Choudhary	MPAUT, Udaipur	udiapur@sorghum.res.in	
11	Dr HC Sharma	ICRISAT, Patancheru	h.sharma@cgiar.org	+919959036661
12	Dr G Shyam Prasad	DSR, Hyderabad	shyam@sorghum.res.in	+919866431157
13	Dr Subbarayudu	DSR, Hyderabad	subba@sorghum.res.in	+919989674550
14	Dr VR Bhagwat, Convener	DSR, Hyderabad	bhagwat@sorghum.res.in	+919490233993