



## AICSIP ENTOMOLOGY PROGRAM – KHARIF- 2016

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

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## Executive summary

### Introduction

Total 196 genotypes were received from AICSIP centers in the form eight trials (AHT-GS, AVT-GS, IHT-GS, IVT-GS, IAVHT-MC, AVHT-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, Ludhiana and Hisar for stem borer and Dharwad, Palem, Akola, Parbhani, Indore, Surat and Udaipur for shoot fly. Four checks (IS 18551, IS 2205, DJ 6514 and Swarna) were included in Entomology trials. Other than regular trials, pest specific trials for shoot pest including mutant lines with a total of 60 lines were evaluated. IPM trials were conducted which comprised of treatments with botanicals, safe chemicals. 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 condition.

### Pest scenario in sorghum

In Punjab the mean shoot fly damage in terms of deadhearts was 40.9 % whereas stem borer damage was 16.0%. In Haryana the shoot fly damage was low (21.5% DH) and 16.6 % damage by stem borer. In Madhya Pradesh severe shoot fly infestation was reported (10-60% DH) and 11 – 35% borer infestation. About 5-10% incidence of earhead bugs was reported. In Maharashtra there was moderate to heavy shoot fly incidence (10 – 14%) but in late sown crop infestation was high (30-55%). Late sown crop in suffered midge attack (20- 25% spikelet damage). In Gujarat Incidence of shoot fly (20-75% DH) and stem borer (10- 78%) was reported. In Rajasthan Shoot fly infestation was recorded at low to moderate intensity (10-27%) whereas it was up to 50-60 per cent in late sown condition. In Telangana the mean shoot fly was moderate (23.8 % DH) and the stem borer damage 17.1% DH. Mean shoot fly incidence at Coimbatore was 15.1% DH. Whereas, the damage due stem borer was from 5.2 – 27 % with an average of 12.0%. The damage due to midge was to the tune of 32 % spikelet damage. There was heavy shoot fly incidence in Karnataka ranging from 15 to 50.00% with an average of 34.5 % deadhearts.

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

*General trend:* Overall, the shoot fly incidence in the trials across the locations ranged from 31.4 – 85.6% the trial mean of all trials being 57.3% DH. The highest incidence of shoot fly was observed at Parbhani (85.2 % DH), followed by Rahuri (83.% DH), Dharwad (65.0% DH). The shoot fly incidence was moderate at Akola (46.9% DH), Palem (51.9% DH), Ludhiana (46.9% DH), Hyderabad (54.4% DH), Surat (43.1% DH) and lowest at Coimbatore (31.4% DH).

*Grain sorghum:* In AHT (GS), AVT (GS), IHT (GS) and IVT (GS) trials, the DH% ranged from moderate to high (31.9 – 81.2%). The mean shoot fly infestation was 63.0, 58.4, 59.0 and 60.4% DH in AHT (GS), AVT (GS), IHT (GS) and IVT (GS), respectively. In AHT (GS), AVT (GS), IHT (GS) and IVT (GS) none of the test entries were superior or on par with resistant check IS 18551

*Forage (multi cut):* The shoot fly damage at peak stage in IVHT-MC was from 22.5 – 71.2% the average was 42.9 %. The entries CSH 24 MF, SSG 59-3, SPH 1806, SPV 2353, Local check recorded low shoot fly damage and was on par with resistant check IS 18551.

*Forage (single-cut):* In AVHT and IVHT, the shoot fly damage was from 21.3 – 71.2% DH. The mean shoot fly deadhearts were 39.9 and 41.2 % DH in AVHT and IVHT, respectively. The promising entries, in AVHT-SC which recorded low DH and were on par with resistant check were SPV 2388, SPV 2387, CSV 21F, SPV 2385, Local check, CSV 30F, SPV 2383. In IVHT-SC, the test entries that recorded lower damage were CSV 30F, SPH 1858(SC), CSV 21F, SPV 2444, SPV 2453, SPV 2445, SPV 2450, SPV 2455. These were on par with resistant check IS 18551.

**Sweet sorghum:** In IVAHT-SS, the damage range was 25.5 – 77.9 % DH with an average of 51.4 % DH at peak stage. The test entries SPH 1861, SPH 1862 recorded low damage due to shoot fly and were on par with resistant check IS 18551.

**AICSP-SPN:** The shoot fly damage in shoot pest nursery ranged from of 31.8 – 73.7 % with average of 52.9 % DH. The entries PVK 902SS, RSSV 397, BNV 364, PVK 1015 recorded low deadhearts and were on par with resistant check IS 18551.

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

**General trend:** Overall, the stem borer incidence in the trials across the locations ranged from 5.3 – 36.9% DH% the trial mean of all trials being 16.8% DH. The highest incidence of shoot fly was observed at Surat (36.9 % DH), followed by Coimbatore (28.1.% DH) and Palem (19.1 % DH). The shoot fly incidence was low at Akola (5.3% DH), Ludhiana (5.6 % DH) and Parbhani (5.7 % DH).

**Grain sorghum:** In in AHT (GS), AVT (GS), the DH% range was 15.1 – 58.0%. The mean stem borer damage in terms of DH % at 45 DAE was 18.9 and 31.5 % in AHT (GS) and AVT (GS), trials, respectively. In AHT (GS) none of the entries were superior or on par with resistant check (IS 2205). In AVT-GS, the entries SPV 2296, SPV 2293, SPV 2301 recorded low stem borer deadhearts% and were on par with resistant check IS 2205. In IHT (GS) and IVT (GS), the DH range was 11.6 – 38.0%. The mean borer infestation was 16.7 and 19.3 % DH in IHT (GS) and IVT (GS), respectively. In IHT-GS, the entries CSH 25, SPH 1853, SPH 1847, SPH 1852, SPH 1850 recorded low damage on par with resistant check (IS 2205). In IVT-GS trial, SPV 2439, CSV 27, LC, SPV 2437, SPV 2436 recorded low and was on par with resistant check IS 2205.

**Forage sorghum ( Multicut):** The stem borer damage at 45 DAE in IAVHT-multi-cut trial ranged from 10.5 – 34.9 with a mean of 17.6 % deadhearts. The test entries were Local check, SPH 1843, SPH 1768, CSH 24MF recorded lower deadhearts on par with resistant check IS 2205.

**Forage sorghum (Single cut):** In single cut trial: The damage was from 12.9 – 40.3 % with a mean of 19.5% deadhearts. In AVHT-SC, the entries CSV 21F, SPV 2317, CSV 30F were on par with resistant check IS 2205. In IVHT-SC, the damage ranged from 11.4 – 51.6 % with mean of 21.5 %DH. The entries CSH 13, SPV 2453 recorded low stem borer damage on par with resistant check (IS 2205).

**Sweet sorghum:** In IVAHT-SS, the damage range was 25.6 – 69.5% with an average of 41.1 % deadhearts at 45 DAE. The entries SPH 1861, SPH 1862, SPH 1825, CSV 24SS, SPV 2462 and CSV 22SS recorded low deadhearts and were on par with resistant cheek (IS 2205).

**AICSP-SPN for major pests:** The entries in shoot pest nursery showed 40.7% deadhearts ranging between 26.3 – 61.8 % deadhearts. The entries that recorded lowest damage were S-652, SPV 2242, SPV 2366, PVK 1015, AKSV 408 and were found on par with resistant check IS 2205.

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

Damage rating (1-9) due to ear head bugs was recorded at Palem and Indore. Unfortunately, the damage was very meager. Therefore not recorded in the centers.

### **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 and Coimbatore only. Across the trials the damage ranged between score of 1.0 – 4.0. The entries recording damage score less than 2.0.were:

In AHT (GS): CSH 30, CSH 16, SPH 1817, SPH 1789, SPH 1779; In AVT-GS: LC, CSV 27, CSV 20, SPV 2357; In

IVT(GS): SPV 2438, SPV 2434; In IAVHT (MC): LC, SSG 59-3, SPV 2242, SPV 2421, SPV 2353; In AVHT (SC): LC, SPH 1752, SPH 1794, CSV 21F, SPH 1797, SPH 1822

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

The damage due midge was recorded only at Coimbatore from 1.0 – 6.5 on a scale of 1-9 damage rating. The incidence was very meager at Palem and hence did not record as observed in last season. The entries that recorded low damage were:

AHT (GS): SPH 1789, Local Check, SPH 1820; In AVT- (GS): SPV 2372, SPV 2373, Local check, CSV 17; In IHT (GS): SPH 1850, SPH 1852, SPH 1851, SPH 1848, SPH 1846; In IVT (GS) : SPV 2432, SPV 2442; In IAVHT- MC: LC, SPV 2422, SPV 2421, SPV 2353, SPH 1770; In AVHT (SC): SPH 1752, SPV 2389, LC, CSV 21F, CSH 13, in IVHT (SC): SPV 2450, SPV 2451, SPV 2448, SPV 2444; In IAVHT (SS): SPH 1862, SPV 2457, CSH 22SS, SPV 2324, SPV 2456 recorded low damage due to midge.

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

The data on aphid population and damage was recorded at Akola only. But the incidence was very low 1-3 rating and hence could not reflected here. But need to watch this pest in Kharif season also in view of changing climate.

**IPM:** IPM trials comprising of seed treatment, use of insecticides sprays and botanicals was taken up at Akola, Parbhani, Dharwad, Indore and Palem. Based upon the data obtained from the five centers it is concluded that the treatment comprising of Sorghum seed treated with Imidacloprid 70 WS @ 3g/seed + whorl application of Carbofuran 3G @ 8 kg/ha at 30 DAE was best treatment leading to decrease in pest incidence and increased grain and fodder yield.

#### **Overall conclusions**

- Dharwad, Parbhani, Rahuri, Akola, Indore, Surat and Udaipur centre to be considered as hot spot for shoot fly screening.
- Hisar, Coimbatore, Surat and Indore to be considered hot spot for stem borer.
- There is an increasing damage of stem borer, midge and mite at Coimbatore, Palem and Surat.
- Interestingly, Coimbatore has witnessed good damage of shoot fly.

#### **Future work plan- Kharif 2017**

- Observations on shoot fly should be recorded at 14 and 28 DAE and data set showing contrast will be used for analysis.
- Dharwad, Parbhani, Rahuri, Akola, Indore, Surat and Udaipur to be considered as hot-spot for shoot fly screening.
- Coimbatore, Dharwad, Parbhani, Palem, Hisar and Surat centre to be considered as hot-spot for testing for stem borer resistance.
- Trials for testing new molecules against shoot fly and stem borer will be taken up.

## **Detailed report**

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

- Telangana State:** Surveys were conducted at seven locations (Palem, Bijnapally, Khanapur, Koduparthi, Vallem, Nalavelly and Thimmapet) in Nagarkurnool district for pest incidence. Local sorghum mostly yellow sorghum was sown by most of the farmers. Very few fields (about 10%) had intercropping with red gram. The shoot fly damage ranges from 15 to 33% averaging 23.8 % deadhearts; the stem borer damage was ranged from 5 to 20 % averaging 17.1 % at 45 DAE. Panicle damage rating due to head bug (1-9 scale) was 1.3 score. Aphid infestation was minimum level 5%. No plant protection measures were undertaken by the farmers

- b. **Tamil Nadu:** Total 24 fields were surveyed in six villages (Thondamuthur, Madhukarai, Kovilpalayam, Athipalayam, Idukari and TNAU). Mostly CO 19 and CO 30 varieties were grown as sole crop. Only nine fields were intercropped with pulses. Shoot fly incidence from 6 - 27% with an average of 15.1%. Whereas, the damage due stem borer was from 5.2 – 27 % with an average of 12.0%. The damage due to midge was to the tune of 32 % spikelet damage. By and large no plant protection measures were undertaken by the farmers.
- c. **Karnataka:** The area under Kharif sorghum is only in Belagavi district in Hukkeri taluka. Mostly private sector hybrids were grown as sole crop. The shoot fly incidence ranged from 15 to 50.00% with an average of 34.5 % deadhearts. The incidence of stem borer was (4.2 %). The incidence of armyworm, midge, grasshopper, head bug and ear head caterpillars was also negligible.
- d. **Maharashtra:** In Marathwada region, 16 fields (locations) were surveyed in Latur, Parbhani and Beed districts. The crops were sown during 20.6.2016 to 30.6.2016 mostly with hybrids. Only six fields were intercropped with pigeon pea. The shoot fly damage was 5-19 with an average of 10.4%. Whereas, stem borer infestation was from 4 – 9 % with 6.1% average. The incidence of midge, shoot bug, aphid was very low. Pest survey was undertaken in Akola, Washim, Yeotmal and Buldana districts. In each district, 4-6 sorghum fields were surveyed; the farmers sown sorghum during July first to third week. In normal sown fields, the shoot fly dead damage was 10-14 %; however, late sown fields it was 30-55% deadhearts damage. With regards to stem borer dead heart damage, it was ranged from 8-20 %; however the midge panicle damage in late sorghum damage was 20-35 %. The aphid damage was observed low during this year. The other pests were at low level in the region.
- e. **Madhya Pradesh:** Survey work was carried out in Indore, Dhar, Jhabua, Badwani, Khargone, Dewas, Rajgarh and Ujjain districts during different stages of sorghum crop. AICSIP trial were also sown by last week of June. Attack of shoot fly was noticed up to 10-60 percent .The sorghum crop was attacked by stem borer up to 11-35 percent. In the later stage of crop, attack of stem borer, shoot bug and earhead pest infestation was observed. Among the ear head pests *Calcoris angustatus* and *Nezara viridula* was noticed to attack the crop plants below economic injury level i.e. 5-10 % with the population of 5-9 bugs per ear head.
- f. **Gujarat:** A Pest survey study was carried out at farm area of Main Sorghum Research Station and surrounding villages of Research Station during different stages of crop. Almost sowing was done during first to second week of July, 2016. Incidence of both major pests i.e. shoot fly and stem borer was medium to high. Attack of shoot fly was noticed up to 20-75 %, while stem borer was noticed up to 10-78%. Among the mite pest was noticed to attack the crop plants very low i.e. 2-5 %. Incidence of ear head pest like, bug and worm was very low.
- g. **Rajasthan:** Periodical survey was conducted at different crop growth stages (vegetative, reproductive and physiological maturity) at Chittorgarh, Rajsamand, Udaipur, Pratapgarh and Dungarpur districts of the Rajasthan. Shoot fly infestation was recorded at low to moderate (10-27%) whereas in the hotspot nursery it was up to 50-60 per cent in late sown condition. However the infestation of other insect pest viz. stem borer, shoot bug, Kharif grass hopper and sorghum midge was recorded at very low level at different crop growth stages.
- h. **Punjab:** Thirty one fields from Five districts (Ludhiana, Fazilka, Muktasar, Bhatinda, Mansa) were surveyed. The sorghum was sown during 15th May 2016 to second week of July, 2015. The shoot fly damage was ranged from 8 - 84% with an average of 40.9 %. Stem borer damage was found from 5 – 25 % with an average of 16.0%. Farmers used insecticides like Decis, Fipronil, Monocrotophos, Cypermethrin Chlorpyrifos, Quinolphos, Prophenphos indicating heavy usage in forage sorghum.
- i. **Haryana:** About 15 fields were surveyed in five villages (Mangaki, Mirzapur, Tokas, Dewa and Aryanagar) for pest damage assessment in Hisar district during Kharif, 2016. The commonly grown varieties were HJ 541, SSG 59-3, HC 136, Duggi. The shoot fly infestation ranged from 9.0 – 33.6% with an average of 21.5 % DH. The stem borer incidence ranged from 8.2- 26.1% deadhearts, the average infestation being 16.6% deadhearts



Promising entries with less susceptibility to key pests of grain and dual-purpose sorghum from different trials, Kharif- 2016 (Location: 6-9)

| Trial      | Shoot fly at peak stage (< 45 DH %)   | Stem borer at 45 DAE (<15.0% DH)  | Midge damage rating (<3.0 rating)  | Mite damage rating (<2.0 rating)   |
|------------|---|---|--|--|
| AHT (GS)   | 36.7 – 79.8 %<br>63.0 %<br>NONE   | 10.8 – 36.2 %<br>18.9<br>NONE   | 1.2 – 5.5<br>3.4<br>SPH 1789, Local check, SPH 1820                      | 1.0 - 3.0<br>2.0<br>CSH 30, CSH 16, SPH 1817, SPH 1789, SPH 1779                 |
| AVT (GS)   | 31.9 – 81.2 %<br>58.4 %<br>NONE   | 15.1 – 58.0 %<br>31.5 %<br>SPV 2296, SPV 2293, SPV 2301                               | 1.7 – 6.3<br>3.8<br>SPV 2372, SPV 2373, Local check, CSV 17              | 1.0 – 3.2<br>2.31<br>Local check, CSV 27, CSV 20, SPV 2357                       |
| IHT (GS)   | 32.4 – 79.7 %<br>59.0 %<br>NONE   | 11.6 – 33.0 %<br>16.7 %<br>CSH 25, SPH 1853, SPH 1847, SPH 1852, SPH 1850             | 1.0 – 5.0<br>2.8<br>SPH 1850, SPH 1852, SPH 1851, SPH 1848, SPH 1846     | 1.0– 3.2<br>2.4<br>NONE  |
| IVT (GS)   | 33.2 – 80.0 %<br>60.4 %<br>NONE   | 13.0 – 38.0 %<br>19.3 %<br>SPV 2439, CSV 27, Local check, SPV 2437, SPV 2436          | 1.3 – 6.3<br>4.75<br>SPV 2432, SPV 2442                                  | 1.2 – 3.2<br>2.41<br>SPV 2438, SPV 2434  |
| IAVHT (MC) | 22.5 – 71.2 %<br>42.9 %<br>CSH 24MF, SSG 59-3, SPH 1806, SPV 2353, Local check                              | 10.5 – 34.9 %<br>17.6 %<br>Local check, SPH 1843, SPH 1768, CSH 24MF                  | 1.0 – 5.2<br>2.40<br>Local check, SPV 2422, SPV 2421, SPV 2353, SPH 1770 | 1.0 – 4.0<br>1.7<br>Local check, SSG 59-3, SPV 2242, SPV 2421, SPV 2353          |
| AVHT (SC)  | 21.3 – 70.1 %<br>39.9 %<br>SPV 2388, SPV 2387, CSV 21E, SPV 2385, Local Check, CSV 30E, SPV 2383            | 12.9 – 40.3 %<br>19.5 %<br>CSV 21E, SPV 2317, CSV 30F                                 | 1.2 – 6.5<br>3.96<br>SPH 1752, SPV 2389, Local check CSV 21F, CSH 13     | 1.0 – 3.4<br>2.3<br>Local check, SPH 1752, SPH 1794, CSV 21F, SPH 1797, SPH 1822 |
| IVHT (SC)  | 20.6 – 68.5 %<br>41.2 %<br>CSV 30F, SPH 1858(SC), CSV 21F, SPV 2444, SPV 2453, SPV 2445, SPV 2450, SPV 2455 | 11.4 – 51.6 %<br>21.5 %<br>CSH 13, SPV 2453   | 1.0 – 5.8<br>3.4<br>SPV 2450, SPV 2451, SPV 2448, SPV 2444               | 1.0 – 3.4<br>2.4<br>Local Check, SPV 2450, SPV 2451, SPV 2449, SPV 2448          |
| IAVHT (SS) | 25.5 – 77.9 %<br>51.4 %<br>SPH 1861, SPH 1862   | 25.6 – 69.5 %<br>41.1 %<br>SPH 1861, SPH 1862, SPH 1825, CSV 24SS, SPV 2462, CSV 22SS | 1.2 – 5.7<br>3.7<br>SPH 1862, SPV 2457, CSH 22SS, SPV 2324, SPV 2456     | -  |
| AICSIP-SPN | 31.8 – 73.7 %<br>52.9 %<br>PVK 902SS, RSSV 397, BNV 364, PVK 1015   | 26.3 – 61.8 %<br>40.7 %<br>S-652, SPV 2242, SPV 2366, PVK 1015, AKSV 408              |  |  |

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 196 genotypes were received from AICSIP centers in the form eight trials (AHT-GS, AVT-GS, IHT-GS, IVT-GS, IAVHT-MC, AVHT-SC, IVHT-SC and IAVHT-SS) were evaluated for pests for resistance/tolerance at the respective hot-pot locations mainly at Coimbatore, Palem, Rahuri, Indore, Surat, Ludhiana and Hisar for stem borer and Dharwad, Palem, Akola, Parbhani, Indore, Surat and Udaipur for shoot fly. Four checks (IS 18551, IS 2205, DJ 6514 and Swarna) were included in Entomology trials. Other than regular trials, pest specific trials for shoot pest including

mutant lines with a total of 60 lines were evaluated. Fish meal was applied in late planted trials to attract shoot fly and to ensure desirable and uniform infestation. 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 fifteen entries of which seven experimental hybrids, three released hybrid checks (CSH -16, 25 and 30), one local check from respective centers, two resistant checks for different pests (IS 2205, IS 18551) and two susceptible checks (DJ 6514, Swarna) were evaluated at nine locations (Akola, Coimbatore, Dharwad, Indore, Palem, Parbhani, Rahuri, Surat and Udaipur) 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 (Coimbatore, Dharwad, Palem, Parbhani, Rahuri, Akola and Surat). The data on shoot fly generated at Udaipur and Indore were not considered as the trials were treated as viliated based on recommendation of monitoring team. At Akola the mean infestation was high (62.7 % DH), the entries Local check (CSH 14) was statistically on par with resistant check IS 18551. At Coimbatore the infestation was low (37.8% DH), the entries SPH 1820 (18.2% DH), CSH 25 (20.0% DH) and CSH 30 (24.4 % DH) were statistically on par with resistant check IS 18551. At Dharwad overall infestation was heavy (70.9 % DH) and none of the entries were comparable to resistant check. At Palem the entries SPH 1789 (43.0% DH) and SPH 1816 (46.7% DH) were on par with resistant check. Shoot fly infestation was exceptionally high at Parbhani (85.5 % DH) and Rahuri (88.2% DH). None of the test entries were on par with resistant check at Parbhani. At Rahuri the Local check (CSH 25) was on par with resistant check. At Surat infestation of shoot fly was low (41.3 %DH), the entries CSH 25, Local check (GJ 42) and SPH 1789 were on par with resistant check. Across the locations, the mean shoot fly deadheart formation was 63.0 % with a range of 36.7 – 79.8 % – 82.5 %. None of the entries were significantly superior to resistant check IS 18551 (Table 1.1).

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Akola, Coimbatore, Dharwad, Palem, Parbhani and Rahuri. The CV% was high at Rahuri. Shoot fly oviposition was heavy at Dharwad (13.4 eggs/ 5plants), while at Rahuri the oviposition was low (5.96 eggs/5plants). At Dharwad the oviposition ranged 11.3 - 16.3 eggs/5 plants with an average of 13.4 eggs/5pts. Overall across the locations oviposition ranges from 5.6 to 10.7 eggs/5 plants. The lowest oviposition was recorded in IS 18551 (5.6 eggs/ 5 plants). None of the test genotypes were on par with resistant check (Table 1.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was recorded in terms of visual damage rating (1-9 scale) at 35 DAE, deadhearts (%) at 45 DAE and stem tunneling (%) at harvest. The data on deadhearts at 45 DAE due to stem borer was recorded at Akola, Coimbatore, Palem, Parbhani and Surat. Except for Surat all centers recorded high CV % (>25%). The borer infestation in terms of deadhearts was maximum at Surat (35.3%) followed by Coimbatore (28.5%) and Palem (18.4%). At Akola and Parbhani infestation was low. At Surat the stem borer deadhearts ranged from 17.9 – 59.4 % with an average of 35.3 % DH. The Local check (GJ 42) and SPH 1820 recorded deadhearts on par with resistant check (IS 2205). Across the locations, the DH% due to stem borer ranged from 10.8 – 36.2 % DH with an average of 18.9 % DH and all the test entries were statistically on par with to resistant check (IS 2205) (Table 1.2).

The data on injury rating (1-9) was recorded at four locations viz., Akola, Coimbatore, Palem and Parbhani. The data recorded high CV% at Akola. The mean leaf injury due to borer was maximum at Coimbatore (4.6) followed by Palem (3.4) and lowest at Akola (1.9). At Coimbatore the damage ranged from 1.7 – 9.0 the mean being 4.67. The entries SPH 1820 and CSH 30 recorded low leaf injury rating. At Palem injury rating ranged from 1.7 – 5.0 with mean of 3.4. Across the locations, the range of leaf injury was from 2.1 to 3.9 with an average of 2.7 in the scale of 1-9. The entries SPH 1817, SPH 1779 and SPH 1820 recorded <2.1 injury rating (Table 1.2). The data on stem tunneling (%) due to borer was recorded during harvest at Coimbatore, Palem, Parbhani and Surat. The data recorded high CV (>25 %) at Parbhani and Surat. At Coimbatore the entries SPH 1820, SPH 1817, CSH 25, SPH 1779 and CSH 30 recorded stem tunneling on par to resistant check (IS 2205). At Palem the entries, CSH 16, SPH 1789, SPH 1816 and SPH 1817 recorded low stem tunneling (Table 1.2).

**Midge (*Stenodiplosis sorghicola* Coq):** The data on midge damage was recorded at Akola and Coimbatore, the infestation was at moderate level. The Coimbatore the mean midge damage rating was 3.71 and it ranged from 1.0 – 9.0. The test entries SPH 1820, SPH 1789, SPH 1816 and SPH 1779 recorded < 2.0 damage score. At Akola the damage ranged from 1.0 – 4.0. None of the entries were on par to check (DJ 6514). The data across locations could not be taken into account due to high CV % (Table. 1.3).

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** Mite is an emerging pest in Southern part of Gujarat and Tamilnadu on Sorghum. The data on mite damage rating was recorded in the scale of 1-9 at Surat and Coimbatore. The damage was severe at Coimbatore while at Akola and Surat incidence was very less. The damage at Coimbatore ranged from 1.0 – 7.7 with an average of 4.87. The test entries, Local check (CO 30), recorded low damage rating (1.0), while the entries CSH 30 and SPH 1778 showed low damage (< 3.7) (Table 1.3).

**Aphid (*Rhopalosiphum maidis*):** The data on aphid plant damage rating was recorded at Akola and the aphid infestation was low (Table 1.3)

**Head bug (*Calocoris angustatus*):** The damage due to head bug was observed at Palem. The damage ranged from 1.0 – 3.0 on 1 – 9 scale indicating low infestation. The mean head bud damage score was 2.04. (Table 1.3).

**Shoot bug (*Peregrinus maidis*):** The damage due to shoot bug was reported from Akola but infestation was low (Table 1.3).

**Days to 50 % flowering:** Days to 50% flowering were recorded at Akola, Palem, Parbhani, Rahuri, and Surat. Across the locations the data was significant at 5% level. Overall, the trial mean was 76.8 days with a range of 72.6 to 82.8 days. The earliest to flower was CSH 30 (71.8 days). DJ 6514 flowered late (84.2 days) (Table 1.4).

**Plant height (Cm):** The data on plant height was recorded at Akola and Parbhani. The entry IS 18551 was tallest (239.1 cm) while Swarna was shortest (Table 1.4).

**Grain yield /plot (1.8 m<sup>2</sup>):** The data on grain yield under un protected condition was recorded at Palem. The highest yield was recorded in SPH 1789 (109.3 g/plot) followed by SPH 1813 (80.3g) (Table 1.4).

**Plant population per plot (1.8 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at Akola, Coimbatore, Dharwad, Palem, Parbhani, Rahuri and Surat. Across the locations, the data on plant stand was significant and ranged from 19.5 to 28.5 plants plot<sup>-1</sup> with an average of 22.7 plants plot<sup>-1</sup> indicating optimum plant stand (Table 1.5).

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

The trial AVT-GS consisted of twenty three entries of which fourteen experimental varieties, four released varietal checks (CSVs 17, 20, 23 and 27), one local check from respective centers, two resistant checks for different pests (IS 2205, IS 18551) and two susceptible checks (DJ 6514, Swarna) were evaluated at nine locations (Akola, Coimbatore, Dharwad, Indore, Palem, Parbhani, Rahuri, Surat and Udaipur) 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 (Coimbatore, Dharwad, Palem, Parbhani, Rahuri, Akola and Surat). The data on shoot fly generated at Udaipur and Indore were not considered as the trials were treated as vitiated on the recommendation of monitoring team. The mean shoot fly infestation was heavy at Parbhani (88.5% DH), Rahuri (79.1% DH) and Dharwad (68.24), while infestation was moderate at other centers.

At Akola the mean shoot fly infestation across entries was 47.3 % DH. Among the entries, CSV 27 (32.6%), CSV 20 (33.5%), CSV 17 (36.8%), SPV 2363 (39.1%) and Local check (SPV 669) were on par with resistant check (IS 18551). At Coimbatore infestation ranged from 27.6 – 80.4% and the mean was 32.9 % DH. The entries SPV 2296 (18.4%), SPV 2308 and SPV 2357 (20.9%) were on par with the resistant check. At Surat infestation ranged from 22.5 – 77.2 % and the mean was 36.9 % DH. The entries SPV 2370 (25.2%), SPV 2293 (26.7%) and SPV 2296 (30.3%) were on par with resistant check (IS 18551). At Dharwad, Palem, Parbhani and Rahuri the shoot fly infestation was heavy and none of the entries were on par with the resistant check (IS 18551). Across the locations the mean infestation ranged from 35.2 - 80.4%, the trial mean infestation was 58.4% DH. None of the entries were on par with resistant check however, the entries SPV 2730, SPV 2293 and SPV 2357 recorded moderate infestation (Table 2.1).

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Akola, Coimbatore, Dharwad, Palem, Parbhani and Rahuri. The CV% was high at Akola, Palem and Rahuri. Shoot fly oviposition was heavy at Dharwad (13.4 eggs/ 5plants), while at Rahuri the oviposition was low (3.12 eggs/5plants). At Dharwad the oviposition ranged 11.3 – 15.7 eggs/5 plants with an average of 13.4 eggs/5pts. Overall across the locations oviposition ranges from 5.2 to 11.3 eggs/5 plants. The lowest oviposition was recorded in IS 18551 (5.2 eggs/ 5 plants). None of test genotypes were on par with resistant check (Table 2.1).



**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was recorded in terms of visual damage rating (1-9 scale) at 35 DAE, deadhearts (%) at 45 DAE and stem tunneling (%) at harvest. The data on deadhearts due to stem borer was recorded at Akola, Coimbatore, Palem, Parbhani and Surat. The infestation was severe at Surat (31.5% DH) followed by Coimbatore (25.8% DH). The borer infestation was low at Parbhani (4.9% DH) and Akola (5.3 % DH). The data from these two locations were not considered due to high CV (> 25.0%). At Coimbatore the damage ranged from 9.1 - 83.3% DH. The entries, SPV 2357, CSV 17, Local check (Co-30), recorded < 12 % DH and were on par with resistant check IS 2205. At Palem the damage ranged from 9.1 - 30.3% DH with mean of 16.6% DH. The entries SPV 2301, SPV 2366, SPV 2363 and SPV 2364 were on par with resistant check (IS 2205). The data from Surat showed range of 15.1 - 58.0% DH, the entries SPV 2296, SPV 2293 and SPV 2301 were on par with resistant check. Across locations, mean damage ranged from 9.8 - 34.4% DH and the trial mean was 16.8% DH. The data was statistically non-significant; however the entries SPV 2301, SPV 2357, CSV 27 recorded less damage (Table 2.2).

The data on injury rating (1-9) was recorded at four locations viz., Akola, Coimbatore, Palem and Parbhani. The data recorded high CV% at Akola and Palem. The mean leaf injury due to borer was maximum at Coimbatore (4.4) followed by Palem (3.1) and lowest at Akola (2.0) and minimum at Parbhani (1.0). At Coimbatore the damage ranged from 3.0 – 8.7 the mean being 4.4. The entries SPV 2372 and CSV 20 recorded low leaf injury rating (3.0). At Palem injury rating ranged from 1.7 – 6.3 with mean of 3.12. Across the locations, the range of leaf injury was from 1.9 to 4.3 with an average of 2.6 on scale of 1-9. The entries SPV 2372 and SPV 2358 recorded < 2.1 injury rating (Table 2.2). The stem tunneling data was recorded at Coimbatore, Palem and Parbhani. At Coimbatore and Palem extensive stem tunneling was recorded while at Parbhani it was less (18.7%). At Coimbatore stem tunneling ranged from 18.9 - 88.2 % while it was 33.1 - 62.3% at Palem. Across the locations the entries SPV 2296, Local checks, SPV 2308 recorded lower stem tunneling.

**Midge (*Stenodiplosis sorghicola* Coq):** The data on midge damage was recorded at Akola and Coimbatore, the infestation was at moderate level. The Coimbatore the mean midge damage rating was 4.52 and it ranged from 1.0 – 9.0. The test entries Local check (Co-30), SPV 2372, SPV 2373, SPV 2358, CSV 17, SPV 2301, SPV 2362 and SPV 2363 recorded low midge damage rating (<3.0) and were on par with resistant check DJ 6514. At Akola the damage ranged from 1.0 – 4.3. The entries SPV 2363, SPV 2296, SPV 2301, SPV 2364 and CSV 27 were on par to check (DJ 6514) and recorded damage < 2.7. The data across locations could not be taken into account due to high CV % (Table. 2.3).

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** Mite is an emerging pest in Southern part of Gujarat and Tamilnadu on Sorghum. The data on mite damage rating was recorded in the scale of 1-9 at Akola, Surat and Coimbatore. The damage was severe at Coimbatore while at Akola and Surat incidence was very less (1.0). The damage at Coimbatore ranged from 1.0 – 7.7 with an average of 4.86. The test entries, Local check (Co 30) and CSV 27 recorded damage rating (<3.0) (Table 2.3).

**Aphid (*Rhopalosiphum maidis*):** The data on aphid plant damage rating was recorded at Akola and the aphid infestation was low (Table 2.3)

**Head bug (*Calocoris angustatus*):** The damage due to head bug was observed at Palem. The damage ranged from 1.0 – 3.0 on 1 – 9 scale indicating low infestation. The mean head bud damage score was 1.78. (Table 2.3).

**Shoot bug (*Peregrinus maidis*):** The damage due to shoot bug was reported from Akola but infestation was low (1.0) (Table 2.3).

**Days to 50 % flowering:** Days to 50% flowering were recorded at Akola, Palem, Parbhani, Rahuri, and Surat. Across the locations the data was significant at 5% level. Overall, the trial mean was 80.8 days with a range of 70.5 to 85.7 days. The earliest to flower was CSV 17 (70.5 days). DJ 6514 flowered late (85.7 days) (Table 2.4).

**Plant height (Cm):** The data on plant height was recorded at Akola and Parbhani. The entry IS 2205 was tallest (230.2 cm) while Swarna was shortest (Table 2.4).

**Grain yield /plot (1.8 m<sup>2</sup>):** The data on grain yield under unprotected condition was recorded at Palem. The highest yield was recorded in CSV 17 (77 g/plot) followed by SPV 2293 (Table 2.4).

**Plant population per plot (1.8 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at Akola, Coimbatore, Dharwad, Palem, Parbhani, Rahuri and Surat. Across the locations, the data on plant stand was significant and ranged from 20.6 - 28.7 plants plot<sup>-1</sup> with an average of 24.0 plants plot<sup>-1</sup> (Table 2.5) indicating optimum plant stand.

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

The trial IHT-GS consisted of eighteen entries of which ten experimental hybrids, three released hybrid checks (CSH -16, 25 and 30), one local check from respective centers, two resistant checks for different pests (IS 2205, IS 18551) and two susceptible checks (DJ 6514, Swarna) were evaluated at nine locations (Akola, Coimbatore, Dharwad, Indore, Palem, Parbhani, Rahuri, Surat and Udaipur) 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 (Coimbatore, Dharwad, Palem, Parbhani, Rahuri, Akola and Surat). The data on shoot fly generated at Udaipur and Indore were not considered as the trials were treated as vitiated based on recommendation of monitoring team. Severe infestation of shoot fly was recorded at Rahuri (85.1% DH), Parbhani (83.3% DH) and Dharwad (66.8% DH). Moderate level of infestation was recorded at Akola (55.7% DH) and Palem (54.8% DH). Low level of infestation was observed at Coimbatore (27.7% DH). At Akola the shoot fly damage ranged from 24.5 - 79.1% DH. None of the test entries were comparable with resistant check. At Coimbatore the infestation ranged from 15.1 - 77.5% DH. The entries SPH 1852, SPH 1854, CSH 25, SPH 1855, SPH 1846, SPH 1853, SPH 1847, SPH 1853, SPH 1847, SPH 1850 and SPH 1851 were on par with resistant check (IS 18551). At Dharwad the damage ranged from 31.7 - 81.7% DH but none of the test entries were on par with resistant check. At Palem the damage due to shoot fly ranged from 32.2 - 76.4% DH, the test entries SPH 1849, SPH 1847, SPH 1851 and Local check (CSV 31) are on par with resistant check. None of the test entries were comparable to resistant check owing to severe infestation. The data from Surat ranged from 23.8 - 72.5 % DH, the test entries SPH 1846, SPH 1850, SPH 1852, Local Check (GJ 42), SPH 1853, SPH 1848 and SPH 1854 were on par with resistant check. Across the locations the shoot fly damage ranged from 23.8 - 72.5% DH, the trial mean was 59.0% DH (Table 3.1). None of the test entries were on par with the resistant check, however the entries Local Check, CSH 25, SPH 1854, SPH 1848 recorded damage below trial mean though non-significant (Table 3.1).

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Akola, Coimbatore, Dharwad, Palem, Parbhani and Rahuri. The CV% was high at Palem. Shoot fly oviposition was heavy at Coimbatore (9.87 eggs/ 5plants), while at Rahuri the oviposition was low (5.94 eggs/5plants). At Coimbatore the oviposition ranged 4.3 – 14.0 eggs/5 plants with an average of 9.87 eggs/5pts. Overall across the locations oviposition ranged from 4.1 to 10.3 eggs/5 plants. The lowest oviposition was recorded in IS 18551 (4.1 eggs/ 5 plants). None of the test genotypes were on par with resistant check (Table 3.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was recorded in terms of visual damage rating (1-9 scale) at 35 DAE, deadhearts (%) at 45 DAE and stem tunneling (%) at harvest. The data on deadhearts at 45 DAE due to stem borer was recorded at Akola, Coimbatore, Palem, Parbhani and Surat. Except for Coimbatore and Surat all centers recorded high CV (> 25%). The borer infestation in terms of deadhearts was maximum at Surat (31.03%) followed by Coimbatore (21.3%) and Palem (18.4%). At Akola and Parbhani infestation was low. At Surat the stem borer deadhearts ranged from 17.4 – 60.3 % with an average of 31.03 % DH. The entry SPH 1853 was on par with resistant check (IS 2205). Across the locations none of the test entries were comparable to resistant check (IS 2205). However, the entries, CSH 25, SOH 1853, SPH 1847 recorded deadhearts lower than the trial mean (Table 3.2).

The data on injury rating (1-9) was recorded at four locations viz., Akola, Coimbatore and Palem. The data recorded high CV% at Akola and Palem. The mean leaf injury due to borer was maximum at Coimbatore (3.7) followed by Palem (3.3) and lowest at Akola (1.9). At Coimbatore the damage ranged from 2.3 – 9.0 the mean being 3.74. The entries CSH 25 and SPH 1852 recorded low leaf injury rating (2.3). Across the locations the entries SPH 1850, CSH 16, SPH 1851 and SPH 1849 recorded low leaf injury (Table 3.2). The data on stem tunneling was recorded at Coimbatore, Palem, Parbhani and Surat. Maximum stem tunneling was observed at Surat (45.8%) followed by Coimbatore (44.9%), and Palem (42.2%). Moderate level of tunneling was observed at Parbhani. Across the locations the entries SPH 1852, SPH 1853, SPH 1851 and CSH 25 recorded low stem tunnels and were on par with check (Table 3.2).

**Midge (*Stenodiplosis sorghicola* Coq):** The data on midge damage was recorded at Akola and Coimbatore, the infestation was at moderate level. At Coimbatore the mean midge damage rating was 2.56 and it ranged from 1.0 – 6.3. At Akola the midge damage score ranged from 1.0 – 5.3 the mean was 3.07. The test entry SPH 1850, SPH 1852, SPH 1851, SPH 1848 recorded low damage score (2.7) and were on par with check (DJ 6514). The data across locations could not be taken into account due to high CV % (Table. 3.3).

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on mite damage rating was recorded in the scale of 1-9 at Akola, Coimbatore and Surat. The damage was severe at Coimbatore while at Akola and Surat

incidence was very less. The damage at Coimbatore ranged from 1.0 – 7.7 with an average of 5.0. The test entries Local check (Co 30, recorded low damage rating (2.7), rest of the entries suffered moderate levels of damage (Table 3.3).

**Aphid (*Rhopalosiphum maidis*):** The data on aphid plant damage rating was recorded at Akola and the aphid infestation was low (Table 3.3)

**Head bug (*Calocoris angustatus*):** The damage due to head bug was observed at Palem. The damage ranged from 1.0 – 2.3 on 1 – 9 scale indicating low infestation. The mean head bud damage score was 1.7 (Table 3.3).

**Shoot bug (*Peregrinus maidis*):** The damage due to shoot bug was reported from Akola but infestation was low (Table 3.3).

**Days to 50 % flowering:** Days to 50% flowering were recorded at Akola, Palem, Parbhani, Rahuri, and Surat. Across the locations the data was significant at 5% level. Overall, the trial mean was 77.5 days with a range of 73.9 to 86.9 days. The entry earliest to flower was CSH 30 (73.9 days). DJ 6514 flowered late (86.9 days) (Table 3.4).

**Plant height (Cm):** The data on plant height was recorded at Akola and Parbhani. The entry IS 2205 was tallest (226.2 cm) while SPH 1851 was shortest (Table 3.4).

**Grain yield /plot (1.8 m<sup>2</sup>):** The data on grain yield under un protected condition was recorded at Palem. The highest yield was recorded in SPH 1853 (138.9 g/plot) followed by SPH 1846 (Table 3.4).

**Plant population per plot (1.8 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at Akola, Coimbatore, Dharwad, Palem, Parbhani, Rahuri and Surat. Across the locations, the data on plant stand was significant and ranged from 16.7 to 26.1 plants plot<sup>-1</sup> with an average of 22.5 plants plot<sup>-1</sup> indicating optimum plant stand (Table 3.5).

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

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

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly were recorded at peak stage at nine locations (Coimbatore, Dharwad, Palem, Parbhani, Rahuri, Akola and Surat). The data on shoot fly generated at Udaipur and Indore were not considered as the trials were treated as vitiated on the recommendation of monitoring team. The mean shoot fly infestation was heavy at Parbhani (86.4% DH), Rahuri (82.8% DH), Palem (69.3% DH) and Dharwad (62.4% DH), while infestation was moderate at other centers.

At Akola the mean shoot fly infestation across entries was 43.7 % DH, the damage ranged from 25.8 – 73.9% DH. None of the entries were on par with resistant check (IS 18551). At Coimbatore infestation ranged from 12.1 – 70.6% and the mean was 34.2 % DH. The entries SPV 2436, SPV 2440, SPV 2439, SPV 2425, SPV 2424 and CSV 17 were on par with the resistant check. At Dharwad the infestation ranged from 36.8 – 79.6, and SPV 2429 was the only entry on par with resistant check. At Palem the damage ranged from 36.9 – 93.3, the entries SPV 2424, SPV 2423 and SPV 2438 recorded damage on par to resistant check. ). At Parbhani and Rahuri the shoot fly infestation was severe and none of the entries were on par with the resistant check (IS 18551). At Surat infestation ranged from 28.0 – 74.1 % and the mean was 44.1 % DH. The entries SPV 2439, SPV 2440, Local check (GJ 42), SPV 2438, CSV 27, SPV 2424 and SPV 2437 were on par with resistant check (IS 1855). Across the locations the mean infestation ranged from 33.2 - 80.0%, the trial mean infestation was 60.4 % DH. None of the entries were on par with resistant check however, the entries CSV 27, SPV 2439 and SPV 2438 recorded moderate levels of infestation in comparison to susceptible check (Table 4.1).

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Akola, Coimbatore, Dharwad, Palem, Parbhani and Rahuri. The CV% was high at Dharwad and Rahuri. Shoot fly oviposition was heavy at Parbhani (12 eggs/ 5plants), while at Rahuri the oviposition was low (5.94 eggs/5plants). Overall across the locations oviposition ranged from 4.7 to 11.5 eggs/5 plants. The lowest oviposition was recorded in IS 2205 (4.7 eggs/ 5 plants). None of the test genotypes were on par with resistant check (Table 4.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was recorded in terms of visual damage rating (1-9 scale) at 35 DAE, deadhearts (%) at 45 DAE and stem tunneling (%) at harvest. The data on deadhearts due to stem borer was recorded at Akola, Coimbatore, Palem, Parbhani and Surat. The data from Akola, Coimbatore, Palem recorded high CV (>25.0%). The infestation was severe at Surat (33.7% DH) followed by Coimbatore (28.8% DH), Palem (21.4 %). The borer infestation was low at Parbhani (6.1% DH) and Akola (6.4 % DH). The data from Surat showed range of 21.0 – 63.2 % DH, the entries SPV 2439, CSV 27, SPV 2438, SPV 2441, SPV 2442, SPV 2424, SPV 2430 and SPV 2425 recorded damage on par with resistant check (IS 2205).

The data on injury rating (1-9) was recorded at four locations viz., Akola, Coimbatore and Palem. The data recorded high CV% at Akola, Palem and Parbhani. The mean leaf injury due to borer was maximum at Coimbatore (4.6) followed by Palem (2.6) and lowest at Akola (1.8). At Coimbatore the damage ranged from 1.7 – 9.0 the mean being 4.6. The entries SPV 2423, SPV 2436, SPV 2425, were on par with resistant check and recorded low leaf injury rating (< 3.0). Across the locations and none of the entries were comparable to resistant and damage rating ranged from 1.6 – 4.4 and the entries SPV 2423, CSV 23, SPV 2440 and SPV 2436 recorded lower (< 2.2) damage rating (Table 4.2).

The stem tunneling data was recorded at Coimbatore, Palem and Parbhani and Surat. At Coimbatore Palem and Surat extensive stem tunneling was recorded while at Parbhani it was less (15.4 %). At Coimbatore stem tunneling ranged from 19.0 - 88.2 %; Palem (33.3 – 60.0%) and Surat (31.8 – 73.5%). Across the locations the tunneling ranged from 23.3 - 56.5 %, the entries SPV 2442, SPV 2441 CSV 27, SPV 2439 and SPV 2425 recorded damage on par with IS 2205, resistant check (Table 4.2).

**Midge (*Stenodiplosis sorghicola* Coq):** The data on midge damage was recorded at Akola and Coimbatore. At Coimbatore the mean midge damage rating was high (6.3) and it ranged from 1.0 – 9.0. The test entries Local check (Co-30), SPV 2442, 2441, 2432 recorded low midge damage rating (< 2.0) and were on par with resistant check DJ 6514. At Akola the damage ranged from 1.0 – 5.0. The entries SPV 2423 was on par to check (DJ 6514) and recorded damage 2.0. The data across locations was not significant however the entries SPV 2432 and SPV 2442 recorded midge damage rating (< 3.0) (Table. 4.3).

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on mite damage rating was recorded in the scale of 1-9 at Akola, Surat and Coimbatore. The damage was severe at Coimbatore while at Akola and Surat incidence was very less (1.0). The damage at Coimbatore ranged from 1.0 – 7.7 with an average of 5.2. The test entries SPV 2438, Local check (Co-30), SPV 2434 recorded damage rating (< 2.0) (Table 4.3).

**Aphid (*Rhopalosiphum maidis*):** The data on aphid plant damage rating was recorded at Akola and the aphid infestation was low (Table 4.3)

**Head bug (*Calocoris angustatus*):** The damage due to head bug was observed at Palem at low intensity. The damage ranged from 1.0 – 3.0 on 1 – 9 scale indicating low infestation. The mean head bud damage score was 1.84 (Table 4.3).

**Shoot bug (*Peregrinus maidis*):** The damage due to shoot bug was reported from Akola but infestation was low (1.0) (Table 4.3).

**Days to 50 % flowering:** Days to 50% flowering were recorded at Akola, Palem, Parbhani, Rahuri, and Surat. Across the locations the data was significant at 5% level. Overall, the trial mean was 78.5 days with a range of 58.7 to 88.0 days (Table 4.4).

**Plant height (Cm):** The data on plant height was recorded at Akola, Indore and Parbhani. The entry IS 18551 was tallest (220.12 cm) while CSV 17 was shortest (Table 4.4).

**Grain yield /plot (1.8 m<sup>2</sup>):** The data on grain yield under unprotected condition was recorded at Palem. The highest yield was recorded in CSV 17 (37.8 g/plot) (Table 4.4).

**Plant population per plot (1.8 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at Akola, Coimbatore, Dharwad, Palem, Parbhani, Rahuri, Indore and Surat. Across the locations, the data on plant stand was significant and ranged from 11.0 – 26.3 plants plot<sup>-1</sup> with an average of 22.4 plants plot<sup>-1</sup> (Table 4.5) indicating optimum plant stand.

#### **Trial 5: Initial Advanced Varietal hybrid Trial (IAVHT-MC) (Locations: 6)**

The trial IAVHT-MC comprised of twenty three entries of which thirteen were experimental hybrids, three experimental varieties, two released varietal checks (CSH24 MF, SSG 59-3), one local check from respective



centers, two resistant checks for different pests (IS 2205, IS 18551) and two susceptible checks (DJ 6514, Swarna) were evaluated at six locations (Akola, Coimbatore, Hisar, Ludhiana, Surat and Udaipur) for resistance/susceptibility to key pests.

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly were recorded at peak stage at six locations (Coimbatore Akola, Coimbatore, Hisar, Ludhiana, Surat and Udaipur). The data on shoot fly generated at Hisar and Udaipur were not considered as the trials were treated as vitiated on the recommendation of monitoring team. The mean shoot fly infestation was heavy at Ludhiana (54.4% DH), Akola (46.8 % DH), Surat (42.9 % DH), while infestation was moderate at Coimbatore (31.7% DH).

At Akola the mean shoot fly infestation across entries was 46.8 % DH, the damage ranged from 17.6 – 75.0% DH. The test entries SPV 2422, SPV 2421, SSG 59-3 and SPV 2353 were on par and better than resistant check (IS 18551). At Coimbatore infestation ranged from 15.0 – 70.8% and the mean was 31.7 % DH. The entries SPH 1807, SPH 1841, Local check (SPV 2242), SPH 1809, SPH 1839, SPH 1844, SSG 59-3 and SPH 1845 were on par with the resistant check. At Ludhiana the damage ranged from 38.3 – 71.0, the entries SPH 1838, SPH 1839, SPH 1844, SPH 1768, SPH 1843, SPH 1840 and SPV 2421 recorded damage on par to resistant check. At Surat infestation ranged from 22.5 – 71.2 % and the mean was 42.9 % DH. The entries CSH 25MF, SSG 59-3, SPH 1806, SPV 2353, Local check (GFS 5), SPH 1840, SPH 1807 were on par with resistant check (IS 18551). Across the locations the mean infestation ranged from 24.8 – 70.8 %, the trial mean infestation was 44.0 % DH. The entries SSG 59-3, SPV 2353, SPH 1807, SPV 2422, and SPH 1806 recorded moderate levels of infestation in comparison to susceptible check (Table 5.1).

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Akola, Coimbatore, and Ludhiana. The CV% was high at Akola and Surat. Shoot fly oviposition was heavy at Akola (9.1 eggs/ 5plants), while at Ludhiana the oviposition was low (4.67 eggs/5plants). Overall across the locations oviposition ranged from 4.1 to 9.78 eggs/5 plants. The lowest oviposition was recorded in IS 18551 (4.1 eggs/ 5 plants). The entries SPH 1845 and SSG 59-3 were on par with resistant check in terms of ovipositional preference (<6.1 eggs/5 plants) (Table 5.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was recorded in terms of visual damage rating (1-9 scale) at 35 DAE, deadhearts (%) at 45 DAE and stem tunneling (%) at harvest. The data on deadhearts due to stem borer was recorded at Akola, Coimbatore, Ludhiana and Surat. The data from Akola, Ludhiana and Surat recorded high C (>25.0). The infestation was severe at Surat (37.3 % DH) followed by Coimbatore (23.9 % DH). Mean infestation was low at Ludhiana (4.9%) and Akola (4.5 %). The data from Coimbatore showed range of 7.3 – 65.5 % DH, the Local check (SPV 2242), SPH 1809 and SPH 1843 recorded damage on par with resistant check (IS 2205). Across the locations the data was non-significant however the entries Local checks, SPH 1843, SPH 1768 and CSH24 MF recorded low damage less than trial mean (17.6% DH).

The data on injury rating (1-9) was recorded at four locations viz., Akola, Coimbatore and Ludhiana. The data recorded high CV% at Akola and Ludhiana. The mean leaf injury rating due to borer was maximum at Coimbatore (4.3 %) followed by Akola (1.4) and Ludhiana (1.2 ). At Coimbatore the damage ranged from 2.0 – 7.7, the mean being 4.3 %. The entries SPH 1844, Local check (SPV 2242) SPH 1768, SPH 1807, were on par with resistant check and recorded low leaf injury rating (< 3.0). Across the locations the data was non-significant however the entries SPH 1844, SPH 1809, SPH 1768, Local checks, SPH 1807 and SPV 2422 recorded low damage ratings (Table 5.2).

The stem tunneling data was recorded at Akola and Coimbatore and it was extensive. At Akola stem tunneling ranged from 12.1 – 79.3 and at Coimbatore (19.0 – 80.7%). Across the locations the tunneling ranged from 17.8 – 80.0 %. The data was non-significant however the entries Local checks, SPH 1839 and SPH 1838 recorded less damage in comparison to susceptible check(DJ 6514) (Table 5.2).

**Midge (*Stenodiplosis sorghicola* Coq):** The data on midge damage was recorded at Akola and Coimbatore. At Coimbatore the mean midge damage rating was high (3.03) and it ranged from 1.0 – 9.0. The test entries Local check (Co-30), SSG 59-3, SPV 2422, SPV 2421, SPV 2353, SPH 1843, SPH 1840, SPH 1839, SPH 1838, SPH 1806 and SPH 1770 recorded low midge damage rating (1.0) and were on par with resistant check DJ 6514. At Akola the damage ranged from 1.0 – 3.33. The entries SPH 1770, SPV 2353, SPV 2421, SPV 2422 and SSG 59-3 recorded low damage rating (1.0). The data across locations was not significant however the entries SPH 1770, SPV 2353, SPV 2421, SPV 2422 and SSG 59-3 recorded low midge damage rating (1.0) (Table. 5.3).



**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on mite damage rating was recorded in the scale of 1-9 at Akola, Surat and Coimbatore. The damage was severe at Coimbatore while at Akola and Surat incidence was very less (1.0). The damage at Coimbatore ranged from 1.0 – 7.0 with an average of 3.06. The test entries SPV 2353, SPV 2421, SPV 2422 and SSG 59-3 recorded low damage rating (1.0) (Table 5.3).

**Aphid (*Rhopalosiphum maidis*):** The data on aphid plant damage rating was recorded at Akola and Ludhiana and the aphid infestation was low (Table 5.3)

**Shoot bug (*Peregrinus maidis*):** The damage due to shoot bug was reported from Akola but infestation was low (1.0) (Table 5.3).

**Days to 50 % flowering:** Days to 50% flowering were recorded at Akola, Ludhiana and Surat. Across the locations the data was significant at 5% level. Overall, the trial mean was 87.4 days with a range of 83.3 to 96.0 days (Table 5.4).

**Plant height (Cm):** The data on plant height was recorded at Akola. The entry IS 18551 was tallest (216.4 cm) while SPH 1844 was shortest (Table 5.4).

**Plant population per plot (1.8 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at Akola, Coimbatore, Ludhiana and Surat. Across the locations, the data on plant stand was significant and ranged from 20.1 - 30.7 plants plot<sup>-1</sup> with an average of 27.5 plants plot<sup>-1</sup> (Table 5.4) indicating optimum plant stand.

#### **Trial 6: Advanced Varietal hybrid Trial- Single cut (AVHT-SC) (Locations: 6)**

The trial AVHT-SC comprised of twenty two entries of which four were experimental hybrids, ten experimental varieties, one released hybrid check (CSH 13) two released varietal checks (CSV 30F, CSV 21F), one local check, two resistant checks for different pests (IS 2205, IS 18551) and two susceptible checks (DJ 6514, Swarna) were evaluated at eight locations (Akola, Coimbatore, Hisar, Ludhiana, Surat and Udaipur) for resistance/susceptibility to key pests.

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly were recorded at peak stage at five locations (Akola, Coimbatore, Hisar, Ludhiana, Surat and Udaipur). The data on shoot fly generated at Hisar and Udaipur were not considered as the trials were treated as vitiated on the recommendation of monitoring team. The mean shoot fly infestation at Ludhiana (46.2 % DH), Akola (43.1 % DH, Surat (45.0 % DH) and the infestation was moderate at Coimbatore (26.01 % DH). At Akola the mean shoot fly infestation across entries was 43.1 % DH, the damage ranged from 15.3 – 80.4 % DH. The test entries SPV 2387, SPV 2388, SPV 2317, CSV 21F, SPV 2383 and SPV 2385 were on par with resistant check (IS 18551). At Coimbatore infestation ranged from 12.4 – 74.6 % and the mean was 26.01 % DH. The entries SPV 2388, SPV 2387, SPV 2385, CSV 30F, SPV 2389, SPH 1822 and SPH 1797 were on par with the resistant check. At Ludhiana the damage ranged from 28.8 – 77.1 % DH, the entries SPV 2388, Local check (PSC 1), CSV 30F, SPH 1797, CSV 21F, SPH 1822, SPH 1794 recorded damage on par to resistant check (IS 18551). At Surat the mean shoot fly infestation ranged from 27.03 – 72.2 % DH, the mean being 45.5% DH, the entries SPH 1752 and SPH 1794 were on par with the resistant check. Across the locations the mean infestation ranged from 21.3 – 70.1 % DH, the trial mean infestation was 39.9 % DH. The entries SPV 2388, 2387, CSV 21F, SPV 2385, Local check, CSV 30F and SPV 2383 were on par to resistant check IS 18551 (Table 6.1).

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Akola, Coimbatore and Ludhiana. The CV was high at Coimbatore and Ludhiana. Shoot fly oviposition was heavy at Akola (8.3 eggs/ 5plants), Coimbatore (4.7 eggs/5 plants), and while at Ludhiana the oviposition was 5.2 eggs/5plants). Overall across the locations the oviposition data was non-significant and ranged from 3.1 to 9.1 eggs/5 plants. The lowest oviposition was recorded on IS 2205 (2.7 eggs/ 5 plants). However, the entries CSV 30F recorded low oviposition (4.0 eggs/ 5 plants) (Table 6.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was recorded in terms of visual damage rating (1-9 scale) at 35 DAE, deadhearts (%) at 45 DAE and stem tunneling (%) at harvest. The data on deadhearts due to stem borer was recorded at Akola, Coimbatore, Ludhiana and Surat. The data from Akola, Coimbatore and Ludhiana recorded high CV (>25.0). The infestation was severe at Surat (40.06 % DH) followed by Coimbatore (26.06 % DH). Mean infestation was low at Ludhiana (5.38 % DH) and Akola (4.53 % DH). The data from Surat showed range of 24.5 – 70.07 % DH, the entries SPH 1794, SPV 2388 and SPV 2391 recorded damage on par with resistant check (IS 2205). Across the locations the data was non-significant however, the entries CSV 21F, SPV 2317, CSV 30F and SPV 2316 recorded low damage less than trial mean (19.5 % DH). The data on injury rating (1-9) was recorded at four locations viz., Akola, Coimbatore

and Ludhiana. The data recorded high CV% at all locations. Across the locations the data was non-significant however the entries CSV 21F, CSV 30 and SPV 2387 recorded low damage ratings (< 2.0). The stem tunneling data was recorded at Coimbatore and Surat and it was extensive. The data from both centers registered high CV. Across the locations the tunneling ranged from 29.4 – 81.1 %. The data was non-significant however the entries SPV 2389, CSV 30F and SPV 2388 recorded less damage in comparison to susceptible check (DJ 6514) (Table 6.2).

**Midge (*Stenodiplosis sorghicola* Coq):** The data on midge damage was recorded at Akola and Coimbatore. At Coimbatore the mean midge damage rating was high (5.4) and it ranged from 1.0 – 9.0. The Local check (SPV 2242), CSH 13 and SPH 1752 recorded low midge damage rating (1.0). At Akola the damage ranged from 1.0 – 4.3. The entries SPV 2388, recorded low damage rating (1.0). The data across locations was not significant, the damage rating ranged from 1.2 – 6.5 the mean being 3.9. However, the entries SPH 1752 and SPV 2389 recorded low midge damage rating (< 2.0) (Table. 6.3).

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on mite damage rating was recorded in the scale of 1-9 at Akola, Coimbatore and Surat. The damage was severe at Coimbatore while at Akola and Surat incidence was very less (1.0). The damage at Coimbatore ranged from 1.0 – 8.3 with an average of 4.8 rating. The test entries Local check and SPH 1752 recorded low damage rating 1.0) (Table 6.3).

**Aphid (*Rhopalosiphum maidis*):** The data on aphid plant damage rating was recorded at Akola and Ludhiana and the aphid infestation was low (Table 6.3)

**Shoot bug (*Peregrinus maidis*):** The damage due to shoot bug was reported from Akola but infestation was low (1.1) (Table 6.3).

**Days to 50 % flowering:** Days to 50% flowering were recorded at Akola and Ludhiana. Across the locations the data was significant at 5% level. Overall, the trial mean was 90.6 days with a range of 78.5 to 98 days (Table 6.4).

**Plant height (Cm):** The data on plant height was recorded at Akola. The entry SPV 2387 was tallest (237.0 cm) while Swarna was shortest (Table 6.4).

**Plant population per plot (1.8 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at Akola, Coimbatore, Ludhiana and Surat. Across the locations, the data on plant stand was significant and ranged from 23.5 – 30.7 plants plot<sup>-1</sup> with an average of 26.6 plants plot<sup>-1</sup> (Table 6.4) indicating optimum plant stand.

#### **Trial 7: Initial Varietal hybrid Trial- Single cut (IVHT-SC) (Locations: 6)**

The trial IVHT-SC comprised of twenty four entries of which three were experimental hybrids, thirteen experimental varieties, one released hybrid check (CSH 13) two released varietal checks (CSV 30F, CSV 21F), one local check two resistant checks for different pests (IS 2205, IS 18551) and two susceptible checks (DJ 6514, Swarna) were evaluated at eight locations (Akola, Coimbatore, Hisar, Ludhiana, Surat and Udaipur) for resistance/susceptibility to key pests.

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly were recorded at peak stage at five locations (Akola, Coimbatore, Hisar, Ludhiana, Surat and Udaipur). The data on shoot fly generated at Hisar and Udaipur were not considered as the trials were treated as vitiated on the recommendation of monitoring team. At Akola the mean shoot fly infestation across entries was 46.0 % DH, the damage ranged from 15.7 – 76.04 % DH. The test entries SPH 1858 (SC), SPV 2444, CSV 30F, CSV 21F and SPV 2454 were on par with resistant check (IS 18551). At Coimbatore infestation ranged from 8.3 – 48.0 % and the mean was 27.3 % DH. The entries CSV 30F, SPV 2445, SPH 1858(SC), SPV 2447, CSH 13, SPH 1857 and CSV 21F were on par with the resistant check. At Ludhiana the damage ranged from 26.7 – 63.2 % DH, the entries SPV 443, SPV 2452, SPV 2450, SPH 1858(SC), SPV 2453 and SPV 2455 recorded damage on par to resistant check (IS 18551). At Surat the mean shoot fly infestation ranged from 27.0 – 68.4 % DH, the mean being 43.8 % DH. None of the entries were on par with the resistant check. Across the locations the mean infestation ranged from 20.6 – 68.5 % DH, the trial mean infestation was 41.2 % DH. The entries CSV 30F, SPH 1858(SC), CSV 21F, SPV 2444 and SPV 2445 were on par to resistant check IS 18551 (Table 7.1).

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Akola, Coimbatore and Ludhiana. The CV was high at all locations. Shoot fly oviposition was low at Akola (1.7 eggs/5plants), Coimbatore (5.3 eggs/5 plants), and while at Ludhiana the oviposition was 5.7 eggs/5plants). Overall

across the locations the oviposition data was non-significant and ranged from 2.9 to 7.7 eggs/5 plants. The lowest oviposition was recorded on IS 2205 (2.9 eggs/ 5 plants) (Table 7.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was recorded in terms of visual damage rating (1-9 scale) at 35 DAE, deadhearts (%) at 45 DAE and stem tunneling (%) at harvest. The data on deadhearts due to stem borer was recorded at Akola, Coimbatore, Ludhiana and Surat. The data from Akola, Coimbatore and Ludhiana recorded high CV (>25.0). The infestation was severe at Surat (41.2 % DH) followed by Coimbatore (31.1 % DH). Mean infestation was low at Ludhiana (5.6 % DH) and Akola (5.4 % DH). The data from Surat showed range of 25.0 – 60.6 % DH, the entries CSH 13 and SPV 2448 recorded damage on par with resistant check (IS 2205). Across the locations the data was non-significant. However, the entries CSH 13, SPV 2453 and SPV 2444 recorded low damage less than trial mean (21.5 % DH). The data on injury rating (1-9) was recorded at three locations viz., Akola, Coimbatore and Ludhiana. The data recorded high CV% at all locations. Across the locations the data was non-significant however the entries SPH 1857, SPV 2447, SPV 2444, SPV 2448 and CSH 13 recorded low damage ratings (< 2.0). The stem tunneling data was recorded at Coimbatore and Surat and it was extensive. Across the locations the tunneling ranged from 25.5 – 82.8 %. The entries Local check, CSV 21F and CSV 30F recorded less damage in comparison to susceptible check (DJ 6514) (Table 7.2).

**Midge (*Stenodiplosis sorghicola* Coq):** The data on midge damage was recorded at Akola and Coimbatore. At Coimbatore the mean midge damage rating was high (4.3) and it ranged from 1.0 – 9.0. The Local check (SPV 2242), SPV 2448, SPV 2450 and CSH 13 recorded low midge damage rating (1.0). At Akola the damage ranged from 1.0 – 4.7. The entries SPV 2444 and SPV 2450 recorded low damage rating (1.0). The data across locations was not significant, the damage rating ranged from 1.0 – 5.8 the mean being 3.4. However, the entries SPV 2450 recorded low midge damage rating (1.0) (Table 7.3).

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on mite damage rating was recorded in the scale of 1-9 at Akola, Coimbatore and Surat. The damage was severe at Coimbatore while at Akola and Surat incidence was very less (1.0). The damage at Coimbatore ranged from 1.0 – 8.3 with an average of 5.1 rating. The test entries Local check (SPV 2242) and SPV 2450 recorded low damage rating (1.0). Across the locations damage ranged from 1.0 – 3.4 rating with an average of 2.41. The entries SPV 2450, SPV 2451, SPV 2449 and SPV 2447 recorded lower damages (< 1.4) (Table 7.3).

**Aphid (*Rhopalosiphum maidis*):** The data on aphid plant damage rating was recorded at Akola and Ludhiana and the aphid infestation was low (Table 7.3)

**Shoot bug (*Peregrinus maidis*):** The damage due to shoot bug was reported from Akola but infestation was low (1.0) (Table 7.3).

**Days to 50 % flowering:** Days to 50% flowering were recorded at Akola Ludhiana and Surat. Across the locations the data was significant at 5% level. Overall, the trial mean was 86.3 days with a range of 80.1 to 92.6 days (Table 7.4).

**Plant height (Cm):** The data on plant height was recorded at Akola. The entry IS 18551 was tallest (220.6 cm) (Table 7.4).

**Plant population per plot (1.8 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at Akola, Coimbatore, Ludhiana and Surat. Across the locations, the data on plant stand was significant and ranged from 22.8 – 31.3 plants plot<sup>-1</sup> with an average of 26.8 plants plot<sup>-1</sup> (Table 7.4) indicating optimum plant stand.

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

##### Trial 8: Initial Advanced Varietal hybrid Trial (IAVHT-SS) (Locations: 8)

The trial IAVHT-MC comprised of twenty two entries of which seven were experimental hybrids, eight experimental varieties, one released hybrid check (CSH 22SS) two released varietal checks (CSV 19SS, CSV 24SS), two resistant checks for different pests (IS 2205, IS 18551) and two susceptible checks (DJ 6514, Swarna) were evaluated at eight locations (Akola, Coimbatore, Hisar, Indore, Ludhiana, Rahuri, Surat and Udaipur) for resistance/susceptibility to key pests.

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly were recorded at peak stage at five locations (Akola, Coimbatore, Ludhiana, Rahuri and Surat). The data on shoot fly generated at Indore, Hisar and

Udaipur were not considered as the trials were treated as vitiated on the recommendation of monitoring team. The mean shoot fly infestation was heavy at Rahuri (82.0 % DH), Akola (49.5 % DH), Ludhiana (48.4 % DH), and Surat (43.5 % DH) while infestation was moderate at Coimbatore (33.6 % DH). At Akola the mean shoot fly infestation across entries was 49.5 % DH, the damage ranged from 21.7 – 75.0% DH. The test entries SPH 1862, CSV 19SS and SPH 1861 were on par and better than resistant check (IS 18551). At Coimbatore infestation ranged from 9.4– 78.2 % and the mean was 33.6 % DH. The entries SPH 1861, SPH 1862 CSV 19SS and SPV 2458 were on par with the resistant check. At Ludhiana the damage ranged from 29.3 – 70.9 % DH, the entries SPV 2462, SPH 1861, SPV 2458 and SPH 1825 recorded damage on par to resistant check (IS 18551). At Rahuri infestation ranged from 39.6 – 98.6 % DH and the mean was 82.0 % DH. None of the entries were on par with resistant check (IS 18551). At Surat the mean shoot fly infestation ranged from 24.4 – 70.0 % DH, the mean being 43.5% DH, the entries SPH 1798, SPH 1825 and SPH 1861 were on par with the resistant check. Across the locations the mean infestation ranged from 25.5 – 77.9 % DH, the trial mean infestation was 43.5 % DH. The entries SPH 1861 and SPH 1862 were on par to resistant check IS 18551 (Table 8.1).

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at Akola, Coimbatore, Ludhiana and Rahuri. The CV% was high at Coimbatore, Ludhiana and Rahuri. Shoot fly oviposition was heavy at Akola (9.4 eggs/ 5plants), Rahuri (7.3 eggs/ 5 plants), Coimbatore (6.4 eggs/5 plants), while at Ludhiana the oviposition was low (4.3 eggs/5plants). Overall across the locations the oviposition data was non-significant and ranged from 3.1 to 9.1 eggs/5 plants. The lowest oviposition was recorded on IS 2205 (3.2 eggs/ 5 plants). However, the entries SPH 1861 and SPH 1862 recorded low oviposition (<5.0 eggs/ 5 plants (Table 8.1).

**Spotted stem borer (*Chilo partellus*, Swinhoe):** The data on spotted stem borer infestation was recorded in terms of visual damage rating (1-9 scale) at 35 DAE, deadhearts (%) at 45 DAE and stem tunneling (%) at harvest. The data on deadhearts due to stem borer was recorded at Akola, Coimbatore, Ludhiana and Surat. The data from Akola, and Ludhiana recorded high CV (>25.0). The infestation was severe at Surat (41.1 % DH) followed by Coimbatore (39.6 % DH). Mean infestation was low at Ludhiana (6.7 % DH) and Akola (3.3 % DH). The data from Coimbatore showed range of 16.3 – 91.7 % DH, the entries SPH 1862, SPH 1861, SPH 1798, SPH 1859, SPH 1858(SS), SPV 2462 recorded damage on par with resistant check (IS 2205). The data from Surat showed range of 25.6 – 69.5 % DH, the entries SPH 1861, SPH 1862, SPH 1825, CSV 24SS, SPV 2462, SPH 1859 and SPV 2460 recorded damage on par with resistant check (IS 2205). Across the locations the data was non-significant however, the entries Local checks, SPH 1861SPV 2462 and SH1859 recorded low damage less than trial mean (22.6% DH). The data on injury rating (1-9) was recorded at four locations viz., Akola, Coimbatore and Ludhiana. The data recorded high CV% at all locations. Across the locations the data was non-significant however the entries SPH 1862, SPH 1861, recorded low damage ratings (< 2.0). The stem tunneling data was recorded at Akola and Coimbatore and it was extensive. At Akola stem tunneling ranged from 17.3 – 78.2% and at Coimbatore (34.3 – 80.8 %). Across the locations the tunneling ranged from 25.8 – 76.6 %. The data was non-significant however the entries SPH 1861 and SPH 1862 recorded less damage in comparison to susceptible check (DJ 6514) (Table 8.2).

**Midge (*Stenodiplosis sorghicola* Coq):** The data on midge damage was recorded at Akola and Coimbatore. At Coimbatore the mean midge damage rating was high (5.0) and it ranged from 1.0 – 9.0. The test SPH 1862 recorded low midge damage rating (1.0). At Akola the damage ranged from 1.3 – 3.3. The entries SPH 1798, recorded low damage rating (1.3). The data across locations was not significant, the damage rating ranged from 1.2 – 5.7 the mean being 3.7 however the entries SPH 1862, SPV 2457 recorded low midge damage rating (< 2.3) (Table. 8.3).

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on mite damage rating was recorded in the scale of 1-9 at Akola, Surat and Coimbatore. The damage was severe at Coimbatore while at Akola and Surat incidence was very less (1.0). The damage at Coimbatore ranged from 1.0 – 7.0 with an average of 4.1. The test entries SPH 1798, CSV 19SS, CSH 22SSSPH 1858 recorded low damage rating (< 1.4) (Table 8.3).

**Aphid (*Rhopalosiphum maidis*):** The data on aphid plant damage rating was recorded at Akola and Ludhiana and the aphid infestation was low (Table 8.3)

**Shoot bug (*Peregrinus maidis*):** The damage due to shoot bug was reported from Akola but infestation was low (1.0) (Table 8.3).



**Days to 50 % flowering:** Days to 50% flowering were recorded at Akola, Ludhiana and Surat. Across the locations the data was significant at 5% level. Overall, the trial mean was 87.4 days with a range of 83.5 to 95.1 days (Table 8.4).

**Plant height (Cm):** The data on plant height was recorded at Akola. The entry IS 18551 was tallest (228.3cm) while DJ 6514 was shortest (Table 8.4).

**Plant population per plot (1.8 m<sup>2</sup>):** The data on plant population per plot (2 rows of 2 m) was recorded at Akola, Coimbatore, Ludhiana and Surat. Across the locations, the data on plant stand was significant and ranged from 14.2 – 25.9 plants plot<sup>-1</sup> with an average of 21.3 plants plot<sup>-1</sup> (Table 8.4) indicating optimum plant stand.

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

One trial comprised of twenty five entries, 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 place in resistance breeding program as sources for shoot pests resistance.

### Trial 9: Evaluation of AICSIP lines for shoot pest resistance (AICSIP-SPN) (Locations: 10)

Thirty entries consisted of twenty five test entries selected from coordinated trials, one released checks (CSV 15) two resistant sources (IS 18551, IS 2205) two susceptible check (DJ 6514 and Swarna) was incorporated. The trial was conducted at ten locations (Coimbatore, Dharwad, Hisar, Indore, Surat, Hyderabad, Ludhiana, Palem, Parbhani and Surat). The trials at Udaipur, Indore and Hisar were vitiated on the recommendation of monitoring team due to low plant stand and poor trial condition.

**Shoot fly (*Atherigona soccata*, Rond):** Deadhearts caused due to shoot fly was recorded at peak stage at four locations (Coimbatore, Dharwad, Ludhiana, Palem, Parbhani, Surat and Hyderabad). At Coimbatore, the damage range was from 8.3 -76.7 % DH with an average of 28.4 %. The data recoded high CV%. At Dharwad the damage range was 35.5 – 71.2 % DH, the average being 56.8% DH, the entries RSSV 350, SPV 2242, SPV 2362, PVK 902 SS, BNV 364 and SPV 2389 were on par with resistant check (IS 18551). At Ludhiana the damage ranged from 22.2 – 70.1% DH and mean shoot fly infestation was 41.7%. The entries PVK 9802SS, RSSV 397, SPV 2389, SPV 2374, and PVK 1015 recorded low shoot fly infestation and were on par with resistant check. At Palem the damage ranged from 30.7 to 80.7 % with an average of 60.1%. The entries RSSV 430, BNV 369, SPV 2296, RSSV 397 and PVK 1015 were on par with resistant check. At Parbhani, the mean was 82.4% DH (exceptionally high) with range of 70.0 to 93.4%. The entries BNV 364, AKSV 408, PVK 1014, PVK 1015 and BNV 369 recorded damage on par with resistant check. At Surat, the data ranges from 25.3 to 77.7 % with an average of 46.8% DH and the entries, PVK 1015, SPV 2366, SPV 2242, SPV 2362 and SPV 2250 recorded damage on par with resistant check. At Hyderabad the damage ranged from 22.6 – 77% and the entries PVK 902SS, BNV 364, BNV 369, RSSV 397 and RSSV 350 were on par with resistant check.

Across the locations and the genotypes, the mean damage was 52.9% and deadhearts ranged from 31.8 – 73.7% DH. The entries 902SS, RSSV 397, BNV 364 and PVK 1015 recorded damage on par with resistant check IS 18551 (Table 9.1).

**Oviposition preference:** The data on eggs per five plants (no) laid by shoot fly was recorded at five locations viz., Coimbatore, Dharwad, Ludhiana, Palem and Parbhani at Coimbatore, Ludhiana and Parbhani the CV% was high and there was no significant difference at 5% level. Across the locations, the entries RSSV 430, PVK 1015, AKSV 408, and RSSV 350 were less preferred for oviposition (Table 9.1).

**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), deadhearts (%) at 45 DAE and stem tunneling at harvest. The data on deadhearts caused due to stem borer was recorded at Coimbatore, Palem, Parbhani and Surat. Across, the locations and genotypes the data was not significant at 5% level but had high CV%. The entries SPV 2366, SPV 2250, SPV 2389 recorded (<18%) deadhearts and was on par with resistant check (IS 2205). The mean deadheart was 24.0 %, ranging from 14.8 to 41.4 %. The tunneling damage due to stem borer was recorded at Coimbatore, Palem, Parbhani and Surat. Across the locations and genotypes the borer tunneling ranged from 36.7 - 60.5% with an average of 48.9%. The entry RSSV 386 recorded tunneling (< 40%) and was on par with resistant check (38.3% Stem tunneling) (Table 9.2).

**Midge (*Stenodiplosis sorghicola* Coq):** The data on spike let damage rating (1-9) due to midge was recorded at Coimbatore. There was no significant differences between genotypes and had high CV%. The midge damage



range was from 1.0 to 9.0 with an average of 5.2. The entries S 652, SPV 2242, SPV 2250, SPV 2296, SPV 2299 recorded lowest spikelet damage (1.0 Score) (Table 9.2).

**Spider mites (*Oligonychus indicus* and *O. pratensis*):** The data on leaf damage rating (1-9) was recorded at Coimbatore. The data statistically was no significant at 5% level and had high CV%. Overall, the mite damage rating ranged from 1.0–3.0 with an av. score of 2.2 indicating very narrow range and moderate incidence. The entries recorded lowest damage (1.0 score) are PVK 1015, PVK 902SS, AKSV 408 and RSSV 430 (Table 9.3).

## VI. Pest management methods in sorghum

There is a need to evaluate newer molecules at AICSIP centers. IPM trials comprising of seed treatment, use of insecticides sprays and botanicals was taken up at Akola, Parbhani, Dharwad, Indore and Palem. The results are presented center wise.

### AKOLA

The IPM trial was taken up at Akola with following treatments

- T1: Sorghum seed treated with Imidacloprid 70 WS @ 3 g/seed
- T2: Sorghum seed treated with Imidacloprid 70 WS @ 3 g/seed + whorl application of Carbofuran 3G @ 8 kg/ha at 30 DAE
- T3: Sorghum seed treated with Imidacloprid 70 WS @ 3 g/seed + spray of 5 % NSKE at 45 DAE
- T4: Sorghum seed treated with Imidacloprid 70 WS @ 3 g/seed + spray of methyl demeton 25 EC @ 2 ml/liter at 45 DAE
- T5: Sorghum with furrow application of Carbofuran 3 G @ 20 kg/ha at 30 DAE
- T6: Sorghum with furrow application of Carbofuran 3 G @ 20 kg/ha at 30 DAE + spray of methyl demeton 25 EC @ 2 ml/liter at 45 DAE
- T7: Sorghum crop without any application (untreated control)

**Table: Efficacy of IPM treatment on pest incidence (Kharif, 2016, Akola)**

Variety: CSV 27; Plot size: 10.8 sq.m

| Treatments | Eggs/5 plants (no.) | SF DH % | SB LIR (1-9) | SB DH % | SB ST % | MG-DR (1-9) | Grain yield kg/plot |
|------------|---------------------|---------|--------------|---------|---------|-------------|---------------------|
| T1         | 12.0                | 46.3    | 2.3          | 3.6     | 31.5    | 4.0         | 2.4                 |
| T2         | 11.0                | 44.3    | 2.0          | 2.9     | 21.7    | 4.7         | 2.6                 |
| T3         | 12.0                | 43.9    | 2.3          | 4.3     | 30.5    | 3.7         | 2.4                 |
| T4         | 14.0                | 46.8    | 2.3          | 4.3     | 28.6    | 4.0         | 2.3                 |
| T5         | 11.3                | 52.4    | 2.3          | 5.2     | 30.0    | 4.0         | 2.0                 |
| T6         | 14.7                | 54.4    | 2.0          | 5.5     | 30.3    | 3.7         | 1.9                 |
| T7         | 17.3                | 72.1    | 4.7          | 6.9     | 32.0    | 4.7         | 1.1                 |
| C.D (0.05) | NS                  | 13.7    | 1.3          | 1.9     | NS      | NS          | 0.7                 |
| C.V (%)    | 28.6                | 14.8    | 27.9         | 22.1    | 22.4    | 22.3        | 18.7                |

SF DH%: Shoot fly deadhearts; SB LIR: Stem borer leaf injury rating; SB DH: Stem borer deadhearts; SB ST: Stem borer stem tunneling; MG DR: Midge damage rating

**Shoot fly:** There was no significant difference in oviposition by shoot fly in all the treatments. In terms of deadhearts the treatments T3 (43.9%), T2 (44.3%), T1 (46.3%), T4 (46.8%), T5 (52.4%) and T6 (54.4%) were on par and significantly superior over the untreated control. There was 39.1% decrease in deadhearts in T3 over the untreated control.

**Stem borer:** In terms of stem borer deadhearts the treatments T2, T1, T3 and T4 were on par and significantly superior over T5, T6 and the untreated control. There was 57.9 % decrease in deadhearts in T2 over the untreated control. There was no significant difference in stem tunneling among the treatments.

**Grain yield/plot:** In terms of grain yield the treatments T2 (2.6kg/plot), T1 (2.4kg/plot), T3 (2.4kg/plot), T4 (2.3kg/plot), T5 (2.0kg/plot) and T6 (1.9kg/plot) were on par and significantly superior over the untreated control (1.1kg/plot). There was 57.6 % increase in grain yield in T2 over the untreated control.

Overall in terms of all parameters the treatment T2 (Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + whorl application of carbofuran 3G @ 8 kg/ha at 30 DAE) was best realizing 57.6% increase in yield over the control.

## PALEM

The IPM trial was taken up at Palem with following treatments

- T1: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed
- T2: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + whorl application of carbofuran 3G @ 8 kg/ha at 30 DAE
- T3: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + spray of 5 % NSKE at 45 DAE
- T4: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + spray Profenophos 50 EC @ 2 ml/litr @ 2 ml/litr at 45 DAE
- T5: Sorghum with furrow application of carbofuran 3 G @ 20 kg/ha at 30 DAE
- T6: Sorghum with furrow application of carbofuran 3 G @ 20 kg/ha at 30 DAE + spray of Profenophos 50 EC @ 2 ml/litr at 45 DAE
- T7: Sorghum crop without any application (untreated control)

**Table: Efficacy of IPM treatment on pest incidence (Kharif, 2016, Palem)**  
Variety: CSV 15; Plot size: 10.8 sq.m

| Treatments | SF DH % | SB DH % | Grain yield g/5plantt | Grain yield kg/5 plants |
|------------|---------|---------|-----------------------|-------------------------|
| T1         | 26.7    | 27.8    | 502.0                 | 0.502                   |
| T2         | 20.0    | 22.2    | 530.0                 | 0.530                   |
| T3         | 31.1    | 38.9    | 492.7                 | 0.493                   |
| T4         | 26.7    | 30.5    | 514.0                 | 0.514                   |
| T5         | 28.9    | 22.2    | 525.2                 | 0.525                   |
| T6         | 37.8    | 33.3    | 478.3                 | 0.478                   |
| T7         | 66.7    | 75.0    | 344.0                 | 0.344                   |
| C.D (0.05) | 16.8    | 6.0     | 65.9                  |                         |
| C.V (%)    | 27.6    | 9.3     | 7.6                   |                         |

SF DH%: Shoot fly deadhearts; SB LIR: Stem borer leaf injury rating; SB DH: Stem borer deadhearts;  
SB ST: Stem borer stem tunneling; MG DR: Midge damage rating

**Shoot fly:** In terms of deadhearts the treatments T2 (20.0%), T1 (26.7%), T4 (26.7%), T5 (28.9%) and T3 (31.1%) were on par and significantly superior over T6 and the untreated control. There was 70.0 % decrease in deadhearts in T2 over the untreated control.

**Stem borer:** In terms of stem borer deadhearts the treatments T2 (22.2%), T5 (22.2%) and T1 (27.8%) were on par and significantly superior over rest of the treatments and the untreated control. There was 70.4 % decrease in deadhearts in T2 and T5 over the untreated control.

**Grain yield/plot:** In terms of grain yield the treatments T2 (0.530 kg/plant), T5 (0.525 kg/plant), T1 (0.514 kg/plant), T4 (0.502 kg/plant), T3 (0.493mg/plant), T6 (0.478 kg/plant) were on par and significantly superior over the untreated control (0.344 kg/plant). There was 54.1 % increase in grain yield in T2 over the untreated control.

Overall in terms of all parameters the treatment T2 (Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + whorl application of carbofuran 3G @ 8 kg/ha at 30 DAE) was best realizing 54.1% increase in yield over the control.

## PARBHANI

The IPM trial was taken up at Parbhani with following treatments

- T1: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed
- T2: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + whorl application of carbofuran 3G @ 8 kg/ha at 30 DAE
- T3: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + spray of 5 % NSKE at 45 DAE
- T4: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + spray of methyl demeton 25 EC @ 2 ml/litr at 45 DAE
- T5: Sorghum with furrow application of carbofuran 3 G @ 20 kg/ha at 30 DAE
- T6: Sorghum with furrow application of carbofuran 3 G @ 20 kg/ha at 30 DAE + spray of methyl demeton @ 2 ml/litr at 45 DAE
- T7: Sorghum crop without any application (untreated control)

**Table: Efficacy of IPM treatment on pest incidence (Kharif, 2016, Parbhani)**

Variety: PKV 809; Plot size: 10.8 sq m.

| Treatments | SF DH % | SB DH % | Grain yield (q/ha) | Fodder yield (q/ha) |
|------------|---------|---------|--------------------|---------------------|
| T1         | 33.0    | 5.4     | 15.7               | 78.7                |
| T2         | 32.3    | 1.9     | 23.3               | 108.0               |
| T3         | 23.3    | 5.0     | 17.3               | 88.0                |
| T4         | 34.9    | 4.4     | 11.9               | 74.1                |
| T5         | 27.5    | 3.3     | 22.8               | 84.9                |
| T6         | 36.6    | 3.4     | 14.2               | 71.0                |
| T7         | 47.0    | 9.3     | 11.2               | 57.1                |
| C.D (0.05) | NS      | 2.2     | 1.8                | 20.4                |
| C.V (%)    | 24.8    | 26.0    | 6.1                | 14.1                |

SF DH%: Shoot fly deadhearts;; SB DH: Stem borer deadhearts;

**Shoot fly:** In terms of deadhearts caused by shoot fly there was no significant difference among the treatments.

**Stem borer:** In terms of stem borer deadhearts the treatments T2 (1.9 %), T5 (3.3 %) and T6 (3.4 %) were on par and significantly superior over rest of the treatments and the untreated control. There was 79.5 % decrease in deadhearts in T2.

**Grain and fodder yield/ha:** In terms of grain yield the treatments T2 (23.3 q/ha) and T5 (22.8 q/ha) were on par and significantly superior over other treatments (T1, T3, T4, T6) the untreated control (11.2 q/ha). There was 108 % increase in grain yield in T2 over the untreated control. In terms of fodder the treatment T2 (108 q/ha) was superior and on par with T3 (88 q/ha).

Overall in terms of all parameters the treatment T2 (Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + whorl application of carbofuran 3G @ 8 kg/ha at 30 DAE) was best higher grain and fodder yields.

#### DHARWAD

The IPM trial was taken up at Parbhani with following treatments

- T1: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed
- T2: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + whorl application of carbofuran 3G @ 8 kg/ha at 30 DAE
- T3: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + spray of 5 % NSKE at 45 DAE
- T4: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + spray of Quinolphos 25 EC @ 2 ml/litr at 45 DAE
- T5: Sorghum with furrow application of carbofuran 3 G @ 20 kg/ha at 30 DAE
- T6: Sorghum with furrow application of carbofuran 3 G @ 20 kg/ha at 30 DAE + spray of Quinolphos 25 EC at 45 DAE
- T7: Sorghum crop without any application (untreated control)

**Table: Efficacy of IPM treatment on pest incidence (Kharif, 2016, Dharwad)**

Variety: DSV 6; Plot size: 10.8 sq m.

| Treatments | SF EGG/5PT | SF DH % | Grain yield (q/ha) | Fodder yield (q/ha) |
|------------|------------|---------|--------------------|---------------------|
| T1         | 10.3       | 44.8    | 23.8               | 75.5                |
| T2         | 9.7        | 48.4    | 24.2               | 75.5                |
| T3         | 10.0       | 52.0    | 26.2               | 67.2                |
| T4         | 10.7       | 47.8    | 28.2               | 74.4                |
| T5         | 10.0       | 54.2    | 25.1               | 62.3                |
| T6         | 10.0       | 48.8    | 27.2               | 76.5                |
| T7         | 13.0       | 51.9    | 24.1               | 67.8                |
| C.D (0.05) | 1.6        | NS      | NS                 | NS                  |
| C.V (%)    | 8.6        | 23.0    | 11.4               | 14.8                |

SF EGG/PT: Shoot fly eggs/5 plants; SF DH%: Shoot fly deadhearts;; SB DH: Stem borer deadhearts;

**Shoot fly:** In terms of shoot fly oviposition, all the treatments were significantly superior to Control. There was no significant difference in deadheart formation among the treatments

**Grain and fodder yield/ha:** In terms of grain and fodder yield there was no significant differences between treatments.

Overall in terms of all parameters there was no significant difference between the treatments.

## INDORE

The IPM trial was taken up at Parbhani with following treatments

- T1: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed
- T2: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + whorl application of carbofuran 3G @ 8 kg/ha at 30 DAE
- T3: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + spray of 5 % NSKE at 45 DAE
- T4: Sorghum seed treated with imidacloprid 70 WS @ 3 g/seed + spray of Quinolphos 25 EC @ 2 ml/litr at 45 DAE
- T5: Sorghum with furrow application of carbofuran 3 G @ 20 kg/ha at 30 DAE
- T6: Sorghum with furrow application of carbofuran 3 G @ 20 kg/ha at 30 DAE + spray of Quinolphos 25 EC at 45 DAE
- T7: Sorghum crop without any application (untreated control)

**Table: Efficacy of IPM treatment on pest incidence (Kharif, 2016, Indore)**  
Variety: RVS 1862; Plot size: 10.8 sq m.

| Treatments | SF DH % | SB DH % | HB- DR (1-9) | Grain yield (q/ha) |
|------------|---------|---------|--------------|--------------------|
| T1         | 18.2    | 18.9    | 4.7          | 356.8              |
| T2         | 10.1    | 10.9    | 2.3          | 464.0              |
| T3         | 13.5    | 14.6    | 3.7          | 416.0              |
| T4         | 16.7    | 17.4    | 3.7          | 396.8              |
| T5         | 24.3    | 25.1    | 5.7          | 280.0              |
| T6         | 30.6    | 31.4    | 7.0          | 244.7              |
| T7         | 42.8    | 35.5    | 7.3          | 145.3              |
| C.D (0.05) | 2.0     | 8.4     | 0.9          | 24.4               |
| C.V (%)    | 4.9     | 21.4    | 10.7         | 4.1                |

SF EGG/PT: Shoot fly eggs/5 plants; SF DH%: Shoot fly deadhearts;; SB DH: Stem borer deadhearts;

**Conclusion:** Based upon the data obtained from the five centers it is concluded that the treatment comprising of Sorghum seed treated with Imidacloprid 70 WS @ 3g/seed + whorl application of Carbofuran 3G @ 8 kg/ha at 30 DAE was best treatment leading to decrease in pest incidence and increased grain and fodder yield.

**VIII. Annexures: Relevant information on publications, trials conducted, parameters, compliance report, hot spots etc**

## Annexure 1: IIMR-AICSIP Publications in Entomology- 2016

### International Journals

1. Anandhi, P. Elamathi, S. and B. Arthi Rani, 2017. Population dynamics and bio-intensive management of sorghum midge, *Contarinia sorghicola* (Coquillett) in sorghum under southern Tamil Nadu, International Journal of Agricultural sciences, (Accepted for publication)

### National Journals

1. Bhandari, G. R., N. V. Radadiya, V. D. Pathak and B. K. Davda (2016). Screening of Different Entries Against Shoot flies and Stem Borer Tolerance In Large Scale Varietal Trial of Grain Sorghum. *Journal of Plant Development Sciences*, Vol. 8 (7): 315-319.
2. Sonalkar V.U and K.S. Pagire. 2017. Reaction of Grain Sorghum Varieties to Major Pests in Vidarbha Region. *Int. J. Curr. Microbiol. App. Sci* 6(2): 891-898.
3. Pagire, K.S., V.U. Sonalkar, Dipali P. Thakare, V.V. Kalpande and V.M. Chavan, 2017. Effectiveness of Insecticidal Sprays against Whitefly Checking Yellow Vein Mosaic Virus (YVMV) Incidence in Okra (*Abelmoschus esculentus* L. Moench), *International Journal of Current Microbiology and Applied Sciences*, 6 (2):362-366, 2017.
4. Pagire, K.S., V.U. Sonalkar, Dipali P. Thakare. 2016. Efficacy of Newer Insecticides Against Whitefly (*Bemisia tabaci* Genn.) on Okra, *Advances in Life Sciences* 5(24):11197-11201.
5. Sonalkar V. U and P. K. Nagre. 2017. Management of Leaf Miner, *Phyllocnistis citrella* in Nagpur Mandarin Young, Orchard Through Spray Schedules, *Trends in Biosciences*, 10 (1): 2010-15.

### Submitted

1. Kumar Ravinder, P.S. Shera, Sharma Sudendu and Sangha K.S (2017) Standardization of release rate of *Trichogramma chilonis* for bio-intensive management of spotted stem borer *Chilo partellus* in fodder maize. (Paper submitted in *Journal of Biological Control*)
2. Sapna, Lekha, Hemant Swami and H. K. Jain. 2017. Estimation of losses due to insect pests in sorghum crop. *Indian Journal of applied Entomology*.

### Technical bulletins

#### Poster/paper presentation in Conference

1. Kumar Ravinder and U. S. Tiwana (2016) Control efficacy of seed dressing insecticides against sorghum shoot fly *Atherigona soccata* in forage sorghum *Sorghum bicolor* (L.) Moench. Oral Presentation in "National conference on Innovative and Current advances in Agriculture and Allied Sciences" held at Prof. Jayashankar Telengana State Agricultural University, Rajendranagar, Hyderabad. from 10-11 December, 2016. PP 38.
2. Kumar Ravinder, U S Tiwana and Devinder Pal Singh (2017) Effect of differential seed rate on stem borer *Chilo partellus* inflicted damage and yield advantage in fodder maize. In National Symposium on New Directions in Managing Forage Resources and Livestock Productivity in 21st century held at Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior on 3-4 March, 2017. PP120.
3. Anandhi, P and C. Gailce Leo Justin, 2016. Eco-friendly approaches for the management of sorghum midge, *Contarinia sorghicola* (Coquillett) in sorghum under southern region of India. Paper published in International Conference on "Contaminated Site Remediation - Cleanup India, 2016 and Soil Health Workshop" on December 13-16, 2016 at TNAU, Coimbatore, Tamil Nadu, India, 678-679p.
4. Anandhi, P and C. Gailce Leo Justin, 2016. Validation of the eco-friendly IPM modules against major pests of sorghum. Paper published in International Conference on "Contaminated Site Remediation - Cleanup India, 2016 and Soil Health Workshop" on December 13-16, 2016 at TNAU, Coimbatore, Tamil Nadu, India, 680-681p.
5. H.K. Sumeriya\*, N.S. Dodiya, J.X. Massey, Arvind Verma, M.K. Kaushik, Hemant Swami and Naval Singh Devra. 2017. Effect of weed management on weed dynamics and productivity of sorghum Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan 313 001 In: Biennial Conference of the Indian Society of Weed Science on "Doubling Farmers' Income by 2022: The Role of Weed Science", MPUA&T, Udaipur, India during 1-3 March, 2017
6. Sapna, Lekha, Hemant Swami, H K Jain and S K Ja. 2017. Seasonal incidence and estimation of losses due to insect pests in sorghum [*Sorghum bicolor* (L.) Monch]. In: International Conference: "Eco Friendly and Socially Responsive Economy and Equity: Issues and Challenges of 21st Century for Emergent Sustainable Development Amongst SAARC Countries" held at College of Science Mohanlal Sukhadia University Udaipur
7. Nemade S. M., N.B.Mohod, R.B.Ghorade V.U.Sonalkar and Shilpa Khambalkar. 2016. Growth And Yield of Sorghum As Affected By Micronutrients ( Zn & Fe) Application. In: Integrated Land Use Planning For Smart Agriculture, Indian Society of Soil Survey and Land Use Planning (NBSSLUP), Nagpur.



8. Nemade, S M., R.B.Ghorade, N.B.Mohod, V.U.Sonalkar and S.B.Thawari. 2016. Sorghum Yield and Economics As Affected By Tillage & Integrated Nutrient Management. In: Integrated Land Use Planning For Smart Agriculture, Indian Society of Soil Survey and Land Use Planning (NBSSLUP), Nagpur.
9. Sonalkar V.U., Shilpa Khambalkar, R.B. Ghorade, Seema Nemade and K.S. Pagire. 2016. Rainfed Sorghum Varieties and Hybrids' Performance Against Insect Pests. In: National Seminar Rainfed agriculture in India : Perspectives and challenges, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, December 7-9, 2016: 49,
10. Sonalkar, V.U., A.K. Sadawarte, Ekta Bagde, M.V. Totawar and D.H. Paithankar. 2016. Management of Citrus Aphids on Nagpur Mandarin in Vidarbha. In: National Seminar Rainfed agriculture in India : Perspectives and challenges, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, December 7-9, 2016: 69,
11. Nemade, S.M. N.B. Mohod, R.B. Ghorade and V.U. Sonalkar. 2016. Effect of Method and Time of Nitrogen Application on Growth and Yield Enhancement of Sorghum. In: National Seminar Rainfed agriculture in India: Perspectives and challenges, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, December 7-9, 2016: 141.
12. Nemade, S. M. R.B. Ghorade, V.U. Sonalkar and N.B. Mohod. 2016. Effect of integrated Nutrient Management on kharif sorghum-rabi chickpea cropping system. In: National Seminar Rainfed agriculture in India: Perspectives and challenges, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, December 7-9, 2016: 141.
13. Seema Nemade, N.B. Mohod, V.U. Sonalkar and K.S. Pagire. 2016. Effect of BBF on Moisture Conservation and Yield of Sorghum. In: National Seminar Rainfed agriculture in India: Perspectives and challenges, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, December 7-9, 2016: 192
14. Sonalkar, V.U., K.S. Pagire, R.B. Ghorade and V.V. Kalpande Reaction of Single cult Sorghum Varieties and Hybrids to Major Insect pest. In: National Seminar Rainfed agriculture in India: Perspectives and challenges, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, December 7-9, 2016: 232
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  13. Ghorade, R. B., Seema Nemade, **V.U.Sonalkar.** 2016. *Jwari: kharif hangamatil ek mahatvache pik, Krishi patrika, June 2016.*
  14. Ghorade, R. B., Seema Nemade, **V.U.Sonalkar.** 2016. *Jwarivaril khodmashi: vyavsthapan, Krishi patrika, July 2016*
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#### Recognition/Awards

1. Shreeshail S Karabhantanal, Scientist (Entomology), AICSIP, RARS, Vijayapur was conferred with "Best Extension Scientist Award" for the Outstanding extension activities carried out by him during 2013-14 and this was awarded on the foundation Day of the University of Agricultural Sciences, Dharwad held on 1st October, 2016
2. Anandhi. P. 2016. Best popular Article Award- First prize at Second National Conference on "Agricultural Scientific Tamil Society" – August 5 & 6, TNAU, Coimbatore, Tamil Nadu.
3. Ravinder Chandel, Young Scientist Award. 2016 National conference on Innovative and current Advances in Agriculture and Allied Science, Held at Prof. Jayashankar Telangana State Agricultural University, Rajendranager, Hyderabad by Society for Scientific Development in Agriculture and Technology, Meerut (UP)

**Annexure 2: AICSIP Entomology trials and nurseries conducted-Kharif 2016**

| Trial No  | Trials                        | Ent | Rep | Plot size (rows x m) | Number of trials to be conducted at each AICSIP centers |          |          |          |          |           |          |           |           |          |          |          | Total     |
|---|-------------------------------|-----|-----|----------------------|---|----------|----------|----------|----------|-----------|----------|-----------|-----------|----------|----------|----------|-----------|
|   |                               |     |     |                      | 1   | 2        | 3        | 4        | 5        | 6         | 7        | 8         | 9         | 10       | 11       | 12       |           |
|   |                               |     |     |                      | Coi   | Dha      | Pal      | Par      | Rah      | Ako       | Ind      | Sur       | Uda       | Lud      | His      | Hyd      |           |
| <b>I. Evaluation of regular/on-going AICSIP trials for key pest resistance</b>  |                               |     |     |                      |   |          |          |          |          |           |          |           |           |          |          |          |           |
| 1   | AHT-GS                        | 15  | 3   | 2r x 2 m             | 1   | 1        | 1        | 1        | 1        | 1         | 1        | 1         | 1         | 0        | 0        | 0        | 9         |
| 2   | AVT-GS                        | 23  | 3   | 2r x 2 m             | 1   | 1        | 1        | 1        | 1        | 1         | 1        | 1         | 1         | 0        | 0        | 0        | 9         |
| 3   | IHT -GS                       | 18  | 3   | 2r x 2 m             | 1   | 1        | 1        | 1        | 1        | 1         | 1        | 1         | 1         | 0        | 0        | 0        | 9         |
| 4   | IVT -GS                       | 29  | 3   | 2r x 2 m             | 1   | 1        | 1        | 1        | 1        | 1         | 1        | 1         | 1         | 0        | 0        | 0        | 9         |
| 5   | IAVHT-MC                      | 23  | 3   | 2r x 2 m             | 1   | 0        | 0        | 0        | 0        | 1         |          | 1         | 1         | 1        | 1        | 0        | 6         |
| 6   | AVHT-SC                       | 22  | 3   | 2r x 2 m             | 1   | 0        | 0        | 0        | 0        | 1         |          | 1         | 1         | 1        | 1        | 0        | 6         |
| 7   | IVHT-SC                       | 24  | 3   | 2r x 2 m             | 1   | 0        | 0        | 0        | 0        | 1         |          | 1         | 1         | 1        | 1        | 0        | 6         |
| 8   | IAVHT-SS                      | 22  | 3   | 2r x 2 m             | 1   | 0        | 0        | 0        | 1        | 1         | 1        | 1         | 1         | 1        | 1        | 0        | 8         |
| <b>II. Interdisciplinary program on basic &amp; strategic research for multi-pest resistance/agronomic characters</b> |                               |     |     |                      |   |          |          |          |          |           |          |           |           |          |          |          |           |
| 9   | AICSIP-SPN                    | 30  | 3   | 2r x 2 m             | 1   | 1        | 1        | 1        |          |           | 1        | 1         | 1         | 1        | 1        | 1        | 10        |
| 10  | Mutant lines for Shoot fly    | 30  | 3   | 2r x 2 m             | 0   | 1        | 0        | 1        | 1        | 1         | 0        | 0         | 0         | 0        | 0        | 0        | 4         |
| <b>III. Validation of IPM modules</b>   |                               |     |     |                      |   |          |          |          |          |           |          |           |           |          |          |          |           |
| 11  | Pest management Tactics       | 7   | 3   | 18 r x 7m            | 0   | 1        | 1        | 1        | 0        | 1         | 1        | 1         | 1         | 1        | 0        | 0        | 8         |
| <b>IV. Pest surveillance, seasonal abundance &amp; population dynamics of sporadic &amp; unusual pest outbreaks</b>   |                               |     |     |                      |   |          |          |          |          |           |          |           |           |          |          |          |           |
| 15  | Pest survey in farmer's field |     | 15  | Farmers field        | 1   | 1        | 1        | 1        | 1        | 1         | 1        | 1         | 1         | 1        | 1        | 0        | 11        |
|   | <b>Total</b>                  |     |     |                      | <b>10</b>   | <b>8</b> | <b>7</b> | <b>8</b> | <b>7</b> | <b>11</b> | <b>8</b> | <b>11</b> | <b>11</b> | <b>7</b> | <b>6</b> | <b>1</b> | <b>95</b> |

**Annexure 3: Entomology trials data-Compliance Report -Kharif 2016**

| S No | Centre     | No of trials allotted | Trials sown | Date Sown            | Data received in time | Trials vitiated |
|------|------------|-----------------------|-------------|----------------------|-----------------------|-----------------|
| 1    | Coimbatore | 10                    | 10          | 22.6.2016            | Yes                   | -               |
| 2    | Palem      | 8                     | 8           | 7.7.2016             | Yes                   | -               |
| 3    | Parbhani   | 7                     | 7           | 1.7.2016 & 15.7.2016 | Yes                   | -               |
| 4    | Akola      | 8                     | 8           | 25.7.2016            | Yes                   | -               |
| 5    | Dharwad    | 7                     | 6           | 23.7.2016            | Yes                   | -               |
| 6    | Indore     | 11                    | 11          | 4.7.2016             | Yes                   | -               |
| 7    | Surat      | 8                     | 8           | 11.7.2016            | Yes                   | 6*              |
| 8    | Rahuri     | 10                    | 10          | 28.6.2016            | Yes                   | -               |
| 9    | Udaipur    | 11                    | 10          | 23.7.2016            | Yes                   | 9*              |
| 10   | Hisar      | 7                     | 7           | 19.6.2016            | Yes                   | 6*              |
| 11   | Ludhiana   | 6                     | 6           | 12.7.2016            | Yes                   | -               |

\*Trials vitiated based on monitoring team recommendation and poor quality of data

**Annexure 4: Hot spots locations for key pests**

| SN No | Centre (Hot spot) | Season      | Key pests                               |
|-------|-------------------|-------------|---|
| 1     | Parbhani          | Kharif/Rabi | Shoot fly                               |
| 2     | Udaipur           | Kharif      | Shoot fly                               |
| 3     | Coimbatore        | Kharif      | Head bug, Stem borer                    |
| 4     | Dharwad           | Kharif/Rabi | Shoot fly, Stem borer                   |
| 5     | Palem             | Kharif      | Shoot fly, Head bug                     |
| 6     | Surat             | Kharif      | Shoot fly, Stem borer, mite             |
| 7     | Indore            | Kharif      | Shoot fly, Stem borer                   |
| 8     | Akola             | Kharif      | Shoot fly, stem borer, aphids           |
| 9     | Bijapur           | Rabi        | Stem borer, Aphid, Shoot bug            |
| 10    | Rahuri            | Kharif/Rabi | Shoot fly, Aphid                        |
| 11    | Hyderabad         | Kharif/Rabi | Shoot fly, Stem Borer, Shoot bug, Aphid |
| 12    | Solapur           | Rabi        | Aphids, shoot bug, shoot fly            |
| 13    | Kovilpatti        | Late Rabi   | Shoot fly, stem borer, midge, mite      |
| 14    | Tandur            | Rabi        | Stem borer, shoot fly, aphids           |
| 15    | Hisar             | Kharif      | Stem borer                              |
| 16    | Ludhiana          | Kharif      | Shoot fly, stem borer                   |

**Annexure 5: The parameters and abbreviations used during data analysis (Refer tables)**

| SL No | Parameters                                   | Abbreviations |
|-------|--|---------------|
| 1     | Plant population at 12 DAE (No)              | PP            |
| 2     | Shoot fly eggs/5 plants at 14 DAE (No)       | SFEG-5PT      |
| 3     | Shoot fly deadhearts (%) - at peak time      | SF-DH%        |
| 4     | Stem borer leaf injury score (1-9) at 35 DAE | SB-LER        |
| 5     | Stem borer deadhearts (%) -45DAE             | SB-DH%        |
| 6     | Stem borer - stem tunneling (%)              | SB-ST%        |
| 7     | Midge - panicle damage rating (1-9)          | MG-DR         |
| 8     | Head bug -panicle damage rating (1-9)        | HB-DR         |
| 9     | Sugarcane aphids-plant damage rating (1-9)   | APH-PDR       |
| 10    | Shoot bug -Plant damage rating (1-9)         | SBG-PDR       |
| 11    | Mite -Plant damage rating (1- 9)             | MT-PDR        |
| 12    | Days to 50% flowering (No)                   | DFL           |
| 13    | Plant height                                 | PLHT          |
| 14    | Grain yield (g)/ 5 plants                    | GY-5PTS       |

**Annexure- 6. : List of Sorghum Entomologists in AICRIP on Sorghum**

| No | Name of Collaborator   | Brief address                           | email  | Contact no  |
|----|------------------------|---|--|---|
| 1  | Dr Hemant Swami        | MPAUT, Udaipur                          | <a href="mailto:hemantswamy@gmail.com">hemantswamy@gmail.com</a>   | +919636999035,<br><a href="tel:+919414169035">+919414169035</a> |
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| 3  | Dr. DN Kambrekar       | UAS, Dharwad                            | <a href="mailto:dharwad@millets.res.in">dharwad@millets.res.in</a><br><a href="mailto:kambrekarnd@gmail.com">kambrekarnd@gmail.com</a>               | +919845516968   |
| 4  | Dr N. Jemimah          | RARS, Palem,                            | <a href="mailto:palem@millets.res.in">palem@millets.res.in</a>   | +919642514947   |
| 5  | Dr. S.S. Karabhantanal | RARS, UAS, Bijapur                      | <a href="mailto:bijapur@millets.res.in">bijapur@millets.res.in</a>   | +919481982960   |
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| 9  | Dr Ravinder Kumar      | PAU, Ludhiana                           | <a href="mailto:dravinderchandel@pau.edu">dravinderchandel@pau.edu</a>   | +919872887311   |
| 10 | Dr. R K Chooudhary     | RVSKVV, COA, Indore                     | <a href="mailto:ravindrachoudhary7@gmail.com">ravindrachoudhary7@gmail.com</a>   | +919425950464   |
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| 12 | Dr. V R Awari          | MPKV Rahuri                             | <a href="mailto:rahuri @millets.res.in">rahuri @millets.res.in</a>   | +917588695373   |
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| 14 | Dr G Shyam Prasad      | IIMR, Hydearbad                         | <a href="mailto:shyam@millets.res.in">shyam@millets.res.in</a>   | +919866431157   |