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# SCREENING OF SORGHUM GENOTYPES FOR RESISTANCE AGAINST *ATHERIGONA SOCCATA* (RONDANI) AND *CHILO PARTELLUS* (SWINHOE) UNDER NATURAL FIELD CONDITIONS

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**SUMMARY**

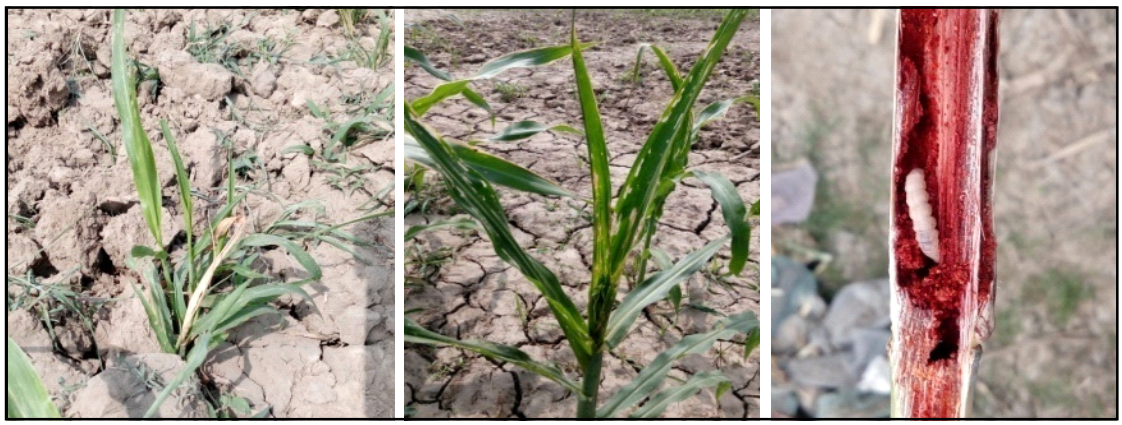
Seventy-three sorghum genotypes were evaluated under six field trials for resistance against shoot fly and spotted stem borer along with commercial, resistant, susceptible and local checks at Hisar during *Kharif,* 2018. Per cent deadhearts caused by shoot fly and stem borer were recorded at 28 and 45 days after emergence, respectively under natural field conditions. Sixteen genotypes *viz*. SPH 1906, SPV 2581, SPV 2586, SPV 2594, SPV 2530, SPV 2531, SPV2597, SPV 2598, SPV 2604, SPV 2521, AKSV 425, RBSV 34, RBSV 36, SFRM 1, SFRM 2, SFRM 3 and SFRM 4 exhibited resistance against shoot fly as these genotypes produced less than 45 per cent deadhearts caused by *Atherigona soccata*. However, the genotype SFRM 1 exhibited resistance against both pests including *A. soccata* and *Chilo partellus* under natural field conditions.

**Key words :** Sorghum, shoot fly, spotted stem borer, resistance, deadheart

*Sorghum bicolor* (L.) Moench commonly known as sorghum is a grass species crop morphologically similar to grain maize and it is grown both as a forage crop for animal feed and a seed crop for food. Sorghum is an important crop grown worldwide for various uses including food as a grain or as sorghum molasses, feed for animals and in the production of alcohol & biofuels. Worldwide, sorghum is cultivated over 40.07 million hectares which produce 57.89 million tonnes of grains with a productivity of 1445 kg/ha. In India, it is cultivated on 4.09 million hectares with a production of 3.48 million tonnes during 2019 (FAO, 2021). The productivity of sorghum in India is 849 kg/ha, which is well below the world's average which is attributed to several factors including abiotic and biotic factors. In north Indian states, this crop is also cultivated for fodder from April to October, which adds further significance to the crop in animal feed.

From seedling to harvest stage, sorghum crop is visited by around 150 insect species and many among these cause considerable damage. Shoot fly, *Atherigona soccata* (Rondani) (Diptera: Muscidae) and spotted stem borer, *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae) are the two major pests of sorghum that affect the quality and quantity of this fodder crop. In India, losses to the tune of 80-90 and up to 68 per cent in the grain and fodder yield, respectively are recorded due to shoot fly alone (Balikai and Bhagwat, 2009; Kahate *et al*., 2014). Spotted stem borer is one of the most serious constraints in increasing yield potential of maize and sorghum, causing yield loss of about 18–25 per cent under different agro-climatic conditions in Asia and Africa (Khadioli *et al*., 2014; Dhaliwal *et al*., 2015). Symptoms of damage by *A. soccata* and *C. partellus* in sorghum are displayed in Fig. 1.

The host-plant resistance, if available is one of the most effective means of managing insect pests. This technique is environment-friendly, compatible with other methods of pest management, does not involve any extra cost of cultivation and has often been used for the successful management of several insect pests in sorghum (Huang *et al.,* 2013). Therefore, the present study was undertaken to screen sorghum genotypes for resistance against *A. soccata* and *C. partellus* under All India Coordinated Research Project (AICRP) trials namely, initial advanced varietal and hybrid trial- multi-cut (IAVHT-MC), advanced varietal and hybrid trial-single cut (AVHT-SC), initial



**Damage of shoot fly** **Damage of stem borer** **Stem borer tunneling**

Fig. 1. Damage symptoms of shoot fly and stem borer in sorghum.

varietal and hybrid trial-single cut (IVHT-SC), initial advanced varietal and hybrid trial-sweet sorghum (IAVHT-SS), high biomass sorghum (HBM) and shoot pest nursery (SPN) during *Kharif*, 2018 under natural field conditions.

## MATERIALS AND METHODS

A total of seventy-three genotypes of sorghum along with commercial checks (CSH 13, CSH 22SS, CSH 24MF, SSG 59-3, CSV 19SS, CSV 24SS, CSV 21F, CSV 30F, CSV 32MF and CSV 32F), local check (HC 136), resistant checks (IS 18551 and IS 2205) and susceptible checks (DJ 6514 and Swarna) constituting six different trials namely, IAVHT-MC, AVHT-SC, IVHT-SC, IAVHT-SS, HBM and SPN were screened for their resistance against *A. soccata* and *C. partellus* at Research Farm of Forage Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar (29°10'N, 75°46'E and 215.2 m above mean sea level) during *Kharif*, 2018 under natural field conditions. Under each trial, two rows of two meters length of each genotype including checks were sown in three replications under randomized block design (RBD) on July 16, 2018 after receiving sufficient rainfall for shoot fly infestation. The monthly mean maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and sunshine varied from 30.8 to 36.4°C, 21.6 to 27.0°C, 78 to 98%, 54 to 87% and 3.0 to 7.6 hrs in cropping period (Fig. 2). A sum of 244.8 mm rainfall was received through 11 rainy days in this period. To maintain optimum plant population, the thinning was done 10 days after emergence. Data on shoot fly and stem borer infestation were recorded in terms of deadhearts at 28 and 45 days after emergence (DAE) of plants, respectively and expressed in percentage. Observations on stem borer tunnelling were recorded as proportion of stem tunnelled by larva at harvest and expressed in per centage. The obtained data were analyzed as per the methods suggested by Gomez and Gomez (1984).

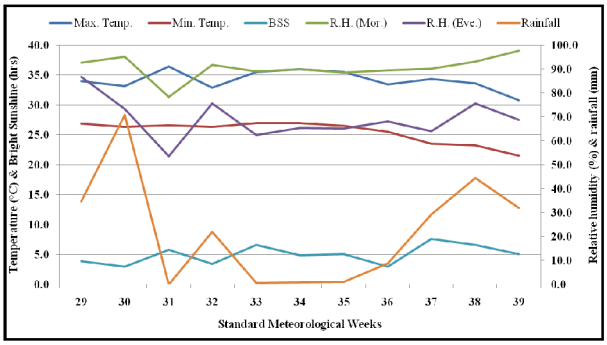



Fig. 2. Weekly meteorological data of cropping period during *kharif* 2018.

## RESULTS AND DISCUSSION

The genotypes of sorghum were screened for resistance against shoot fly and stem borer at Hisar location, which is an identified hot spot for stem borer. The data on deadhearts were recorded at peak activities of the shoot fly (28 DAE) and stem borer (45 DAE). The genotypes showing less than 45 and 15 per cent deadhearts caused by shoot fly and stem borer are considered to possess resistance against *A. soccata* and *C. partellus*, respectively (Anonymous 2019). Deadheart has been reported as a stable parameter to ascertain resistance against these pests. Several workers have used deadheart as a criterion for stem borer resistance (Prasad *et al.,* 2015, Kumar *et al.*, 2019, Sharma *et al.,* 2020). Stem tunnelling is also

important and it has been used as a measure of genotypic susceptibility to *C. partellus* (Sharma *et al.,* 2020). Arora *et al.* (2021) have also studied several morphological and biochemical characters for resistance against *A. soccata* in sorghum genotypes which can be used as markers for selecting resistant germplasm.

Shoot fly and stem bore infestation in terms of deadhearts ranged from 29.1 to 78.2 and 16.4 to 39.5 per cent, respectively under IAVHT-MC trial (Table 1). Genotypes namely, SPH 1881, SPH 1906 and CSV 33MF (CC) were statistically at par in terms of shoot fly infestation with resistant checks (IS 18551 & IS 2205) as well as local check (HC-136). However, none of the genotypes under IAVHT-MC trial was recorded to exhibit resistance against stem borer. Deadheart infestation due to stem borer was lowest (16.4-16.7%) in resistant check. Significant differences were observed in stem borer tunneling across the genotypes which varied from 7.0 to 27.6 per cent.

In AVHT-SC trial, the infestation due to shoot fly and stem borer varied from 29.1 to 76.1 and 11.7 to 40.0 per cent deadhearts, respectively (Table 2). Except resistant checks (IS 2205 & IS 18551) and local check (HC-136), all the tested genotypes were found susceptible to shoot fly infestation. Similarly, both the checks were found to be resistant to stem borer infestation, however local check (HC-136) and rest of the genotypes were found as susceptible. Stem borer tunneling varied from 7.0 to 27.6 per cent. These findings are in line with Anonymous (2019) who also concluded that none of the genotypes showed resistance against these pests.

The infestation in terms of deadhearts caused by shoot fly and stem borer ranged from 29.5 to 76.0 and 11.7 to 39.2 per cent, respectively in IVHT-SC trial (Table 3). Genotypes namely SPV 2581, SPV 2586, SPV 2594 were recorded as resistant against shoot fly (<45% deadhearts). Only one genotype (SPV 2594) was found to possess resistance at par with resistance checks (IS 18551 & IS 2205) whereas

TABLE 1
Screening of genotypes for insect pest resistance under IAVHT-MC

| Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) | Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) |
|---|---|---|---|---|---|---|---|
| SPH 1840 | 64.5 | 31.1 | 13.9 | CSH 24MF (CC) | 51.2 | 29.5 | 13.9 |
| SPH 1877 | 65.8 | 32.4 | 17.7 | SSG 59-3 (CC) | 50.4 | 21.5 | 9.8 |
| SPH 1879 | 55.8 | 29.2 | 13.2 | CSV 33MF (CC) | 38.2 | 24.4 | 13.2 |
| SPH 1881 | 48.2 | 27.1 | 11.1 | HC 136 (LC) | 32.9 | 22.0 | 9.5 |
| SPH 1904 | 53.3 | 25.4 | 15.0 | IS 8551 (RC) | 29.1 | 16.7 | 7.1 |
| SPH 1905 | 52.5 | 27.1 | 13.4 | IS 2205 (RC) | 29.4 | 16.4 | 7.0 |
| SPH 1906 | 43.3 | 26.2 | 11.9 | DJ 6514 (SC) | 78.2 | 39.5 | 22.8 |
| SPH 1907 | 60.6 | 32.7 | 16.5 | Swarna (SC) | 75.0 | 36.8 | 27.6 |
| SPV 2563 | 61.1 | 30.5 | 13.9 | C.D. (5%) | 19.4 | 6.5 | 5.8 |
| SPV 2564 | 71.9 | 32.7 | 15.6 | | | | |

CC: Commercial check; LC: Local check; RC Resistant Check; SC: Susceptible check.

TABLE 2
Screening of genotypes for insect pest resistance under AVHT-SC

| Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) | Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) |
|---|---|---|---|---|---|---|---|
| SPH 1890 | 65.7 | 37.5 | 15.9 | CSV 21F (CC) | 52.0 | 26.0 | 17.6 |
| SPH 1891 | 76.0 | 36.8 | 19.5 | HC 136 (LC) | 35.8 | 22.2 | 10.5 |
| SPV 2445 | 52.7 | 24.9 | 15.5 | IS 18551 (RC) | 29.1 | 13.7 | 7.1 |
| SPV 2451 | 69.6 | 35.9 | 16.4 | IS2205 (RC) | 29.1 | 11.7 | 7.0 |
| CSH 13 (CC) | 57.0 | 34.9 | 18.9 | DJ 6514 (SC) | 76.1 | 39.5 | 22.8 |
| CSV 30F (CC) | 56.3 | 32.4 | 19.4 | Swarna (SC) | 73.3 | 40.0 | 27.6 |
| CSV 32F (CC) | 65.7 | 35.4 | 15.4 | C.D. (5%) | 9.7 | 5.9 | 9.2 |

CC: Commercial check; LC: Local check; RC Resistant Check; SC: Susceptible check.

TABLE 3
Screening of genotypes for insect pest resistance under IVHT-SC

| Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) | Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) |
|---|---|---|---|---|---|---|---|
| SPH 1917 | 61.2 | 28.9 | 10.9 | SPV 2591 | 45.4 | 25.6 | 14.2 |
| SPH 1918 | 62.6 | 33.5 | 22.6 | SPV 2592 | 47.8 | 25.5 | 11.7 |
| SPH 1919 | 67.6 | 33.7 | 17.8 | SPV 2593 | 69.7 | 32.3 | 14.6 |
| SPV 2580 | 53.7 | 24.2 | 15.8 | SPV 2594 | 37.6 | 24.6 | 14.3 |
| SPV 2581 | 40.5 | 26.7 | 10.2 | CSH 13 (CC) | 53.7 | 34.9 | 18.9 |
| SPV 2582 | 50.7 | 31.4 | 14.3 | CSV 30F (CC) | 56.3 | 32.4 | 19.4 |
| SPV 2583 | 61.8 | 29.9 | 14.1 | CSV 32F (CC) | 65.7 | 35.4 | 15.4 |
| SPV 2584 | 64.2 | 31.6 | 12.2 | CSV 21F (CC) | 52.0 | 26.0 | 17.6 |
| SPV 2585 | 70.0 | 33.7 | 16.5 | HC 136 (LC) | 36.8 | 22.2 | 10.5 |
| SPV 2586 | 43.8 | 28.0 | 8.7 | IS 18551 (RC) | 29.8 | 13.7 | 7.1 |
| SPV 2587 | 49.2 | 30.7 | 14.6 | IS2205 (RC) | 29.5 | 11.7 | 7.0 |
| SPV 2588 | 66.0 | 34.3 | 16.7 | DJ 6514 (SC) | 74.9 | 39.2 | 22.8 |
| SPV 2589 | 72.1 | 32.6 | 17.4 | Swarna (SC) | 76.0 | 37.2 | 27.6 |
| SPV 2590 | 57.0 | 30.6 | 15.4 | C.D. (5%) | 10.1 | 8.6 | 8.9 |

CC: Commercial check; LC: Local check; RC Resistant Check; SC: Susceptible check.

remaining two genotypes (SPV 2581, & SPV 2586) were significantly at par with local check (HC-136) in terms of resistance against shoot fly. Except resistant checks (IS 2205 & IS 18551), none of the genotypes was found to be resistant against stem borer infestation. Stem tunneling due to *C. partellus* ranged from 7.0 to 27.6 per cent. These findings are contrary to Anonymous (2019) who reported SPV 2591 and SPV 2592 exhibited less susceptibility against *C. partellus.*

Deadhearts caused by shoot fly and stem borer varied from 28.6 to 75.4 and 11.7 to 44.4 per cent, respectively in IAVHT-SS trial (Table 4). Four genotypes namely, SPV 2530, SPV 2531, SPV 2597 and SPV 2604 were found statistically at par with both the resistant checks (IS 2205 & IS 18551) in terms of deadhearts caused by shoot fly infestation. However, except resistant checks, all the genotypes tested under the trial were observed as susceptible that exhibited >15% deadhearts caused by stem borer. Stem borer tunneling varied from 7.0 to 27.6 per cent with minimum and maximum in resistant and susceptible check, respectively. Anonymous (2019) summarized that none of the genotypes was found resistant against these pests at a national level.

In HBM trial (Table 5), only resistant checks *i.e.,* IS 2205 and IS 18551 exhibited resistance against

TABLE 4
Screening of genotypes for insect pest resistance under IAVHT-SS

| Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) | Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) |
|---|---|---|---|---|---|---|---|
| SPH 1880 | 52.3 | 32.8 | 20.1 | SPV 2602 | 68.0 | 37.3 | 16.8 |
| SPV 2462 | 46.4 | 36.7 | 19.7 | SPV 2603 | 66.5 | 31.1 | 17.0 |
| SPV 2528 | 58.0 | 32.1 | 14.9 | SPV 2604 | 32.2 | 20.5 | 11.3 |
| SPV 2530 | 40.1 | 20.8 | 12.6 | SPV 2605 | 61.8 | 35.7 | 24.5 |
| SPV 2531 | 29.7 | 18.1 | 9.2 | CSH 22 SS (CC) | 64.3 | 36.8 | 16.1 |
| SPV 2595 | 48.4 | 32.3 | 16.3 | CSV 19 SS (CC) | 50.6 | 29.7 | 15.0 |
| SPV 2596 | 54.1 | 30.0 | 13.1 | CSV 24SS (CC) | 59.6 | 22.9 | 11.8 |
| SPV 2597 | 40.2 | 20.3 | 10.1 | IS 18551(RC) | 29.3 | 13.7 | 7.1 |
| SPV 2598 | 41.6 | 26.0 | 13.1 | IS2205 (RC) | 28.6 | 11.7 | 7.0 |
| SPV 2599 | 68.6 | 32.5 | 14.9 | DJ 6514 (SC) | 75.4 | 39.5 | 22.8 |
| SPV 2600 | 62.4 | 31.7 | 11.5 | Swarna (SC) | 73.2 | 44.4 | 27.6 |
| SPV 2601 | 72.8 | 38.4 | 15.9 | C.D. (5%) | 11.7 | 12.0 | 6.3 |

CC: Commercial check; RC Resistant Check; SC: Susceptible check.

TABLE 5
Screening of genotypes for insect pest resistance under HBM trial

| Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) | Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) |
|---|---|---|---|---|---|---|---|
| SPH 1797 | 64.9 | 30.4 | 20.9 | SPV 2611 | 70.3 | 36.0 | 20.9 |
| SPH 1798 | 71.1 | 35.8 | 18.1 | CSH 13 (CC) | 57.9 | 36.2 | 18.7 |
| SPV 2402 | 61.6 | 36.4 | 20.7 | CSH 22 SS (CC) | 64.3 | 35.7 | 16.1 |
| SPV 2606 | 71.0 | 34.7 | 17.1 | IS 8551 (RC) | 29.3 | 13.7 | 7.1 |
| SPV 2607 | 61.8 | 33.7 | 20.2 | IS 2205 (RC) | 28.6 | 11.7 | 7.0 |
| SPV 2608 | 48.4 | 26.4 | 14.8 | DJ 6514 (SC) | 75.4 | 39.5 | 22.8 |
| SPV 2609 | 66.5 | 36.0 | 19.6 | Swarna (SC) | 72.8 | 36.8 | 27.6 |
| SPV 2610 | 66.6 | 35.9 | 24.0 | C.D.(5%) | 16.4 | 5.7 | 8.11 |

CC: Commercial check; RC Resistant Check; SC: Susceptible check.

shoot fly infestation (<45% deadhearts) whereas rest of the genotypes were found to be susceptible (>45% deadhearts). Similar trends of resistance against stem borer were observed as no genotype except resistant checks (IS 2205 & IS 18551) were found to have resistance against stem borer and these genotypes produced >15% deadhearts due to stem borer. Similarly, stem borer tunneling was lowest in resistant checks. These findings are in conformity with those of Anonymous (2019).

Shoot fly infestation ranged from 28.6 to 75.4% whereas stem borer infestation ranged from 11.7 to 40.3% under SPN trial (Table 6). Seven genotypes namely, AKSV 425, RBSV 34, RBSV 36, SFRM 1, SFRM 2, SFRM 3 and SFRM 4 showed at par infestation by shoot fly with resistance checks (IS 2205 and IS 18551). However, genotype SFRM 1 exhibited resistance against both the pests (<45% and <15% deadhearts caused by shoot fly and stem borer infestation, respectively). Genotype SFRM 1 also exhibited less stem tunneling by *C. partellus.* The observations of SFRM 1 and SFRM 4 in case of shoot fly are in line with Anonymous (2019).

## CONCLUSION

It is concluded from the trials conducted that a total of sixteen genotypes namely, SPH 1906, SPV 2581, SPV 2586, SPV 2594, SPV 2530, SPV 2531, SPV2597, SPV 2598, SPV 2604, SPV 2521, AKSV 425, RBSV 34, RBSV 36, SFRM 2, SFRM 3 and SFRM 4 exhibited resistance against shoot fly as these genotypes produced less than 45 per cent deadhearts caused by *A. soccata*. However, the genotype SFRM 1 was found to exhibit resistance against both the pests that produced <45 and <15 per cent deadhearts due to shoot fly and stem, respectively.

TABLE 6
Screening of genotypes for insect pest resistance under SPN

| Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) | Genotype | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) |
|---|---|---|---|---|---|---|---|
| SPV 2521 | 44.8 | 24.6 | 11.0 | RBSV 36 | 26.9 | 15.5 | 8.1 |
| SPV 2522 | 61.2 | 27.2 | 11.3 | SFRM 1 | 26.0 | 13.1 | 7.2 |
| SH 1532 | 62.5 | 30.2 | 16.4 | SFRM 2 | 29.7 | 15.3 | 8.1 |
| SR 2872 | 68.7 | 33.3 | 21.4 | SFRM 3 | 37.6 | 18.5 | 8.9 |
| SR 2949 | 63.5 | 34.0 | 19.1 | SFRM 4 | 39.0 | 18.4 | 9.5 |
| SR 2957 | 72.7 | 34.4 | 19.3 | IS 18551 (RC) | 29.3 | 13.7 | 7.1 |
| AKSV 385 | 72.8 | 34.4 | 22.6 | IS 2205 (RC) | 28.6 | 11.7 | 7.0 |
| AKSV 424 | 53.8 | 33.3 | 18.4 | DJ 6514 (SC) | 75.4 | 39.5 | 22.8 |
| AKSV 425 | 30.0 | 23.4 | 15.1 | Swarna (SC) | 72.8 | 40.3 | 23.5 |
| RBSV 33 | 45.4 | 25.4 | 13.8 | C.D. (5%) | 12.2 | 16.2 | 8.3 |
| RBSV 34 | 29.2 | 20.5 | 13.2 | | | | |

CC: Commercial check; LC: Local check; RC Resistant Check; SC: Susceptible check.

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