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# PERFORMANCE OF SORGHUM GENOTYPES AGAINST *ATHERIGONA SOCCATA* (RONDANI) AND *CHILO PARTELLUS* (SWINHOE) INSECTS UNDER NATURAL FIELD CONDITIONS

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## SUMMARY

Eighty sorghum genotypes possessing forage and sweet sorghum characters along with standard resistant, susceptible and local checks were screened for resistance to major insect pests including sorghum shoot fly and spotted stem borer under natural field conditions at Hisar (Haryana), India during rainy season (*kharif*) - 2019. Per cent deadhearts caused by shoot fly and stem borer were recorded at 28 and 45 days after emergence, respectively, under natural field conditions. Fifteen genotypes namely, RBSV 36, SFRM 4, SFRM-6, SFRM-8, SFRM-9, SPH 1881, SPH 1933, SPV 2669, CSH 24MF, SSG 59-3, CSV 33MF, SPV 2712, SPV 2604, SPV 2692 and CSV 19SS performed better by registering less percentage of deadhearts caused by *Atherigona soccata* and *Chilo partellus*.

**Key words :** Sorghum, screening, insect resistance, deadhearts, stem borer and stalk tunnelling

Among coarse cereals sorghum [(*Sorghum bicolor* L. (Moench)] is one of the most important crops in the semi-arid tropics worldwide. It stands on fifth position after wheat, rice, maize and barley (Khalil, 2008). This crop is having food, feed, fodder fuel potential and mainly grown in the dry climates of Africa, India, Pakistan, China and South U.S. (Somani and Taylor, 2003). In India, a total of 3.48 million tonnes of sorghum grains were produced over the acreage of 4.09 million hectares in 2019 (FAO, 2021). The productivity of sorghum in India is 849 kg/ha which is well below the world's average of 1445 kg/ ha).In North Indian states, sorghum is mainly cultivated for fodder purpose in *kharif* season. Forage genotypes exhibits profuse tillering (in case of multicut), faster growth and produce highly palatable and nutritious green and dry fodder which could be utilized as hay and silage in addition to fresh fodder (Ahmed *et al.,* 2019).

Out of 150 insect pests reported on sorghum, shoot fly [*Atherigona soccata* (Rondani) (Diptera: Muscidae)] and spotted stem borer [*Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae)] are the most important pests which causes significant yield losses. Several workers including Balikai and Bhagwat (2009) and Kahate *et al.* (2014) reported that in India, *A. soccata* alone causes grain yield loss upto 80-90 per cent and around 68 per cent loss in fodder yield. Dhaliwal *et al.* (2015) reported that *C. partellus* causes around 18-25 per cent losses in sorghum and maize only in Asia. Among different management options, the host-plant resistance is environment-friendly, compatible with other control methods, which 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 focused on screening of sorghum genotypes for the natural infestation of shoot fly and spotted stem borer under different trials *viz.,* Shoot Pest Nursery, IAVHT- MC, HBM and IAVHT-SS during *kharif* 2019.

## MATERIALS AND METHODS

Field trials on performance of sorghum genotypes were conducted at Forage Section Research Farm, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar, Haryana with geographical position of 29°10'N, 75°46'E under natural field conditions during *kharif* 2019. Each trial was sown in randomized block design with plot size harbouring two rows of two meters' length on July 18, 2019 and replicated thrice. Eighty sorghum genotypes along with two resistant checks (IS 18551 (check for shoot fly) and IS 2205 (check for stem borer) and susceptible (DJ 6514 and Swarna) were evaluated for resistance to *A. soccata* and *C. partellus*. Thinning was done at 12 days after emergence in order to maintain optimum plant population. Observations on shoot fly and stem borer deadheart were recorded at 28 and 45 days after emergence, respectively. From each plot, total number of plants and total number of deadhearts were counted which were later used for calculating the per cent deadhearts with a formula as given below:

$$\text{Deadheart (\%)} = \frac{\text{Number of plant showing deadheart}}{\text{Total number of plants in the plot}} \times 100$$

The stem borer tunnelling was also recorded as proportion of stem tunnelled by larva at harvest and expressed in per cent. The data were analysed as per the methods suggested by Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

Eighty sorghum genotypes were screened for their resistance to shoot fly and stem borer at Hisar. Data on deadhearts recorded at peak activities of the shoot fly (28 DAE) and stem borer (45 DAE) were considered for screening genotypes as a stable parameter to ascertain resistance against these pests (Singh *et al.,* 1968). The genotypes showing less than 45 and 15 per cent deadhearts caused by shoot fly and stem borer, respectively were considered as resistant against *A. soccata* and *C. parellus* (Anonymous 2018). Several workers have used deadheart as a criterion for evaluation of genotypes against stem borer resistance (Prasad *et al*. 2015, Kumar *et al*., 2019, Sharma *et al*., 2020, Jakhar *et al*., 2021). Stem was tunneling also used as a measure of genotypic susceptibility to *C. partellus* (Jakhar *et al.,* 2021). Arora *et al.* (2021) also studied several morphological and biochemical characters for resistance against *A. soccata* in sorghum genotypes.

In Shoot Pest Nursery (SPN) trial (Table1), the per cent deadheart ranged 15.5 to 53.0 & 5.2 to 14.2 for shoot fly and stem borer, respectively. Genotypes namely, SFRM-9, RBSV-33, RBSV-36 SFRM -2 SFRM -6, SH 1590, SFRM-4, SFRM-8, SFRM-11, SFRM-3, and SFRM-7 were at par with resistant check in case of shoot fly. In case of shoot borer, the deadhearts were maximum in susceptible checks (13.4 and 14.2 % in DJ 6514 and Swarna, respectively).

TABLE 1

Screening of genotypes for insect pest resistance under shoot pest nursury during *Kharif* 2019

| S. No. | Genotype | Shoot fly dead hearts (%) | Stem borer dead hearts (%) | Stem borer (%) |
|---|---|---|---|---|
| 1. | SPV-2521 | 32.3 | 6.0 | 14.2 |
| 2. | SPV-2522 | 37.9 | 7.6 | 20.1 |
| 3. | RBSV-33 | 21.3 | 10.6 | 18.0 |
| 4. | RBSV-34 | 30.0 | 7.8 | 27.0 |
| 5. | RBSV-36 | 20.2 | 5.4 | 25.5 |
| 6. | SFRM-1 | 29.8 | 7.3 | 23.9 |
| 7. | SFRM-2 | 20.5 | 11.5 | 29.5 |
| 8. | SFRM-3 | 26.1 | 11.9 | 21.8 |
| 9. | SFRM-4 | 24.0 | 7.7 | 24.5 |
| 10. | SFRM-5(M20-7-5-R) | 21.7 | 9.9 | 23.1 |
| 11. | SFRM-6(M4-8-1-P) | 20.0 | 7.2 | 24.6 |
| 12. | SFRM-7(M4-92-1-H) | 26.3 | 11.1 | 23.6 |
| 13. | SFRM-8(M4-82-1-P) | 24.5 | 4.8 | 23.8 |
| 14. | SFRM-9(M4-51-3-R) | 15.5 | 7.0 | 30.1 |
| 15. | SFRM-10(M4-78-2-R) | 29.7 | 9.3 | 20.4 |
| 16. | SFRM-11(M4-1-2-R) | 25.4 | 10.2 | 30.0 |
| 17. | SFRM-12(M4-98-1-H) | 36.3 | 5.3 | 25.6 |
| 18. | SH 1485 | 34.0 | 7.6 | 9.7 |
| 19. | SH 1590 | 24.5 | 7.6 | 12.8 |
| 20. | IS18551(RCSF) | 19.8 | 6.8 | 11.4 |
| 21. | IS2205(RCSB) | 20.9 | 5.2 | 13.5 |
| 22. | DJ6514(SCSF) | 53.0 | 13.4 | 24.5 |
| 23. | SWARNA(SCSB) | 43.8 | 14.2 | 23.7 |
| | C.D. (5%) | 7.7 | 3.6 | 10.2 |

RCSF : Resistant check for shoot fly, SCSF : Susceptible check for shoot fly, RCSB : Resistant check for stem borer, SCSB : Susceptible check for stem borer.

Significant difference was also recorded in stem borer tunnelling among the genotypes which varied from 9.7 to 29.5 percent. Low tunnelling suggests that the larvae either took more time to enter inside the stem of these genotypes or fewer larvae survived on these genotypes. Alghali (1987) reported that extent of stem tunnelling is influenced by antibiosis and also used to measure genotypic susceptibility to *C. partellus*.

In IAVHT-MC Trial, seventeen genotypes were tested along with five checks and all genotypes found to possess resistance up to some extent against shoot fly (Table 2); however, the maximum shoot fly infestation were recorded in genotypes SPH-1932 (40.7%) which is at par with susceptible checks, Swarna and DJ 6514 (40.3 & 37.4 %, respectively). At 45 days after emergence, the deadheart caused by stem borer ranged between 10.8 per cent in resistant check (IS 2205) to 23.7 per cent in susceptible check

(Swarna). Minimum stem tunnelling recorded in IS 2205 (6.1%) and maximum in Swarna (30.4%).

The deadheart caused by shoot fly and stem borer ranged between 9.1 to 57.3 and 3.3 to 29.2 per cent, respectively in HBM trial (Table 3). Only one genotype (SPV 2712) was found at par with resistant check (IS 2205 & IS 18551). Genotypes namely, SPV 1712, SPV 2402 and SPH 1798 were found to possess resistance against stem borer with 5.1, 11.7 and 14.1 per cent deadheart respectively at 45 days after emergence. Genotype SPV 2712 showed multiple resistances against both shoot fly and stem borer. Stem borer tunneling ranged between 9.4 per cent in resistant check (IS 2205) to 29.2 per cent in susceptible check (Swarna).

In IAVHT - SS trial (Table 4), the genotypes namely CSV19 SS (17.4%), SPV 2692 (17.4%) and SPV 2604 (23.1%) showed at par infestation of shoot fly with resistant checks IS 18551 (11.9 %) and IS 2205 (13.6%). The maximum shoot fly infestation was recorded in susceptible checks DJ 6514 (56.5%) and Swarna (58.8%). Stem borer infestation ranged 3.8 to 16.8 per cent with minimum and maximum in resistant (IS 18551) and susceptible (Swarna) checks, respectively. The genotypes namely, SPV 2692, SPV 2604 and CSV 19 SS exhibited resistance against both the pests. The stem borer tunnelling ranged 6.2 to 32.1 per cent which is lowest in IS 2205 (6.2%) and highest in Swarna (32.1%).

Resistance to shoot fly is a cumulative effect of non-preference and antibiosis (Raina *et al*., 1981). Antibiosis to shoot fly has been reported by Jotwani and Srivastva (1970), Sharma *et al.* (1977) and Dillon *et al.* (2005). Deadheart parameter was reported to the most stable parameters for differentiating degree of resistance with respect to borer (Singh *et al.* 1968). Several workers have used deadheart as a criterion for stem borer resistance (Singh and Rana 1989; Prasad *et al.,* 2015; Kumar *et al*., 2019 Jakhar *et al.,* 2021). Some bio-chemicals such as malic acid, phenolic compounds, cellulose, hemi-cellulose, lignin, free amino acids etc. of crops could be responsible for resistance to insect pests (Jakhar *et al.,* 2018).

## CONCLUSION

Fifteen genotypes namely, RBSV-36, SFRM-4, SFRM-6, SFRM-8, SFRM-9, SPH 1881, SPH 1933, SPV 2669,CSH 24MF, SSG 59-3, CSV 33MF,SPV 2712, SPV 2604, SPV 2692 and CSV 19 SS performed better against shoot fly and spotted stem borer infestation under natural field conditions. These genotypes can be

TABLE 2
Screening of genotypes for insect pest resistance under IAVHT-Multicut Trial during *kharif* 2019

| S. No. | Genotype | Pedigree | Shoot fly deadhearts (%) | Stem borer deadhearts (SB DH %) | Stem borer tunneling (%) |
|---|---|---|---|---|---|
| 1. | SPH1879 | NSS1006A × HC 308 | 38.2 | 18.7 | 13.5 |
| 2. | SPH1881 | 11A2 × Pant Chari 6 | 30.9 | 15 | 10.6 |
| 3. | SPH1904 | * | 37.3 | 20.4 | 24.8 |
| 4. | SPH1905 | * | 23.6 | 17.5 | 14.7 |
| 5. | SPH1906 | * | 33.3 | 17.1 | 16.8 |
| 6. | SPH1907 | * | 38.9 | 23 | 19 |
| 7. | SPH1932 | * | 40.7 | 20.2 | 24.8 |
| 8. | SPH1933 | * | 29.7 | 13.8 | 11.5 |
| 9. | SPH1934 | ICSA 469 × Pant Chari 6 | 34.3 | 14.9 | 8.1 |
| 10. | SPH1935 | * | 39.4 | 14.1 | 19.7 |
| 11. | SPV2668 | 27A-Sorghum × CM211 Maize | 32 | 12.2 | 15.5 |
| 12. | SPV2669 | CSV15 × UTMC 534 | 27.9 | 13.7 | 16.9 |
| 13. | SPV2670 | IS3267 × UPMC 512 | 39.1 | 20.5 | 15.5 |
| 14. | SPV2671 | SGL87 × S 241-1-7-4-3 | 25.4 | 20.4 | 19.5 |
| 15. | CSH 24MF | ICSA465 × PC-6 | 27.9 | 14.3 | 21.9 |
| 16. | SSG 59-3 | Selection from non-sweet Sudan grass × JS263 | 23.3 | 13.2 | 14.7 |
| 17. | CSV 33MF | EMS Mutant of COFS29 | 25.3 | 12.5 | 19 |
| 18. | Local Check | HC136 | 36.2 | 13.1 | 18.5 |
| 19. | IS 18551(RCSF) | Germplasm line | 20.9 | 11.3 | 9.7 |
| 20. | IS 2205(RCSB) | Germplasm line | 20.9 | 10.8 | 6.1 |
| 21. | DJ 6514(SCSF) | Germplasm line | 37.4 | 20.4 | 26 |
| 22. | Swarna (SCSB) | Selection from IS 3924 | 40.3 | 23.7 | 30.4 |
| | CD (p=0.05) | | 11.5 | 5.8 | 10.8 |

RCSF : Resistant check for shoot fly, SCSF : Susceptible check for shoot fly, RCSB : Resistant check for stem borer, SCSB : Susceptible check for stem borer.

TABLE 3
Screening of genotypes for insect pest resistance under High Biomass Trial during *kharif* 2019

| S. No. | Genotype | Pedigree | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) |
|---|---|---|---|---|---|
| 1. | SPH 1798 | 185 A x RSSV 260 | 39.7 | 14.1 | 23.9 |
| 2. | SPV 2402 | (PC 5 x I-12)-5-1-3-3 | 35.3 | 11.7 | 19.1 |
| 3. | SPV2610 | ICSV 15021-1 | 22.9 | 18 | 26.5 |
| 4. | SPV2611 | ICSV 15006-2 | 44.5 | 20.6 | 17.3 |
| 5. | SPV2712 | SSV 30 X RSSV 216 | 15.3 | 5.1 | 17.9 |
| 6. | SPV2713 | 1-1-2-3-3-6= (CSV20 X E233) | 30.5 | 15.2 | 20.8 |
| 7. | SPV2714 | 41-6-2-2-2= (I12 X CSV23) E 214 | 41.1 | 17.1 | 21.1 |
| 8. | CSH 13 | 296A × RS29 | 49.1 | 16.4 | 16 |
| 9. | CSH 22 SS | ICSA38 × SSV84 | 51.8 | 29.2 | 18.9 |
| 10. | IS 18551 (RCSF) | Germplasm line | 11.9 | 3.3 | 17.3 |
| 11. | IS 2205 (RCSB) | Germplasm line | 9.1 | 5.1 | 9.4 |
| 12. | DJ 6514 (SCSF) | Germplasm line | 44.6 | 17.8 | 22.8 |
| 13. | Swarna (SCSB) | Selection from IS3924 | 57.3 | 23.3 | 29.2 |
| | CD (p=0.05) | | 8.4 | 7.7 | 11.4 |

RCSF : Resistant check for shoot fly, SCSF : Susceptible check for shoot fly, RCSB : Resistant check for stem borer, SCSB : Susceptible check for stem borer.

TABLE 4
Screening of genotypes for insect pest resistance under IAVHT-Sweet Sorghum during *kharif* 2019

| S. No. | Genotype | Pedigree | Shoot fly deadhearts (%) | Stem borer deadhearts (%) | Stem borer tunneling (%) |
|---|---|---|---|---|---|
| 1. | SPV2529 | [(NSSV 13 x IS 21890)-6-1-1 x Atlas]-1-2-1 | 37.7 | 11.7 | 13.1 |
| 2. | SPV2530 | NSSV 259 x RSSV 24 | 24.8 | 7.1 | 13.9 |
| 3. | SPV2600 | (Honey × N 98 Tall)-1-1-1-1-1-1 | 43.9 | 9.7 | 15.8 |
| 4. | SPV2601 | (SPV 1870 × SSV 74)-5-2-2-1-1 | 38.0 | 10.2 | 17.0 |
| 5. | SPV2602 | (SPV 1871 × SSV 74)-5-2-1-1-1 | 31.2 | 12.7 | 23.1 |
| 6. | SPV2604 | ICSV 93046-1 | 23.1 | 6.0 | 12.4 |
| 7. | SPV2692 | DRT 7K × RSSV 167 | 17.4 | 7.4 | 24.8 |
| 8. | SPV2693 | RSSV 267 × RSSV 167 | 27.2 | 7.8 | 18.8 |
| 9. | SPV2694 | (SSV 84 × IS 21890)-1-1-1-2-1-1-1 | 38.0 | 10.1 | 11.6 |
| 10. | SPV2695 | (SSV 84 × EC 582508)-3-1-1-1-2-1-2-1-2 | 30.6 | 9.8 | 10.7 |
| 11. | SPV2696 | (SSV 84 × EC 582508)-4-1-1-1-2-1-1-1 | 32.6 | 11.5 | 14.2 |
| 12. | SPV2697 | (SSV 1871 × SSV 74)-5-2-1-1-1-1 | 33.5 | 10.5 | 11.6 |
| 13. | SPV2698 | (SSV 1871 × SSV 74)-5-2-1-1-1-2 | 27.4 | 10.5 | 17.9 |
| 14. | SPV2699 | K-18-SSR 9-(SPV 1616 × SSV 74)-3-1-1-2-1 | 27.3 | 10.3 | 26.1 |
| 15. | SPV2700 | K-18-SSR 12 (RSCN 2103 × SSV 84)-2-1-2-1-1-1 | 50.6 | 11.7 | 24.6 |
| 16. | CSH 22 SS | ICSA 38 × SSV 84 | 48.7 | 12.6 | 22.4 |
| 17. | CSV 19 SS | RSSV × SPV 462 | 12.5 | 6.8 | 23.7 |
| 18. | CSV 24SS | NSS 1005A × SSV84 × 401B | 34.5 | 11.3 | 16.5 |
| 19. | IS 18551(RCSF) | Germplasm line | 11.9 | 3.8 | 11.5 |
| 20. | IS 2205 (RCSB) | Germplasm line | 13.6 | 5.5 | 6.2 |
| 21. | DJ 6514 (SCSF) | Germplasm line | 56.5 | 12.9 | 14.0 |
| 22. | Swarna (SCSB) | Selection from IS 3924 | 58.8 | 16.8 | 32.1 |
| | CD (p=0.05) | | 11.8 | 2.7 | 11.5 |

RCSF : Resistant check for shoot fly, SCSF : Susceptible check for shoot fly, RCSB : Resistant check for stem borer, SCSB : Susceptible check for stem borer.

further evaluated under advance screening programmes for resistance against these pests.

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