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REACTION OF SORGHUM GENOTYPES AGAINST SHOOT FLY AND SPOTTED STEM BORER FOR RESISTANCE

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SUMMARY

Sixty-two forage sorghum genotypes were evaluated against shoot fly, *Atherigona soccata* Rondani and spotted stem borer *Chilo partellus* Swinhoe during *Kharif* 2021 at Forage Section Research Farm, CCS HAU, Hisar (India). The data on leaf glossiness was recorded on visual score basis and shoot fly and stem borer dead heart per cent was also worked out. Genotypes *viz*., SPH 1995, SPV 2705, SPV 2704, CSV 21F, SPV 2797 and SPV 2878 were recorded resistance to shoot fly, having less dead heart per centage. Genotypes viz., SPV 2861, SPH 1993, SPH 1967, SPV 2705, SPV 2801, SPV 2704, SPV 2800, CSV 30F, SPV 2886, SPV 2878, SPV 2881 & CSH 36F were reacting as resistance against stem borer.

Key words: *Atherigona soccata, Chilo partellus* dead heart, screening, sorghum

Sorghum [*Sorghum bicolor* (L.) Moench] is mostly used as food and fodder crop. It is primarily cultivated for fodder in Haryana. It is cultivated on marginal, fragile, and drought-prone environments in the semi-arid tropics. Sorghum is also grown for forage, and is fed to animals as a green chop, silage or hay.

The fodder yield and quality of sorghum produced is affected by a wide array of biotic and abiotic constraints. However, absence of improved genotype, weed control, plant protection, fertilizer and irrigation resulted in 39, 33, 31, 30 and 22 per cent losses in the productivity of fodder sorghum as compared to full package of practices during *kharif* season (Satpal *et al*., 2021). More than 150 insect pests attack on sorghum from seedling stage to maturity. (Jotwani *et al*., 1980; Sharma, 1993), of which sorghum shoot fly, *A. soccata* and spotted stem borer, *C. partellus* are serious pest that reduces sorghum production in the semi-arid tropics. Due to shoot fly damage, a loss of 80–90% of grain, and 68% of fodder yield was recorded in India. Kahate *et al*., 2014). The losses caused by *C. partellus* in maize and sorghum ranged from 18-25 per cent in Asia (Dhaliwal *et al.,* 2015). The sorghum shoot fly, *Atherigona soccata* (Rondani) attack between 7 and 28 days after seedling emergence (Nwanze *et al.*, 1990). Spotted stem borer, *C. partellus*, attacks sorghum from 2 weeks after germination until crop harvest and affects all plant parts except the roots. The older larvae of the both insect bore into the stem and reach the growing point, where it cuts the growing point resulting in a characteristic ‘‘dead heart’’ symptom. Agronomical practices, natural enemies, synthetic insecticides, and host plant resistance have all been proposed to mitigate losses incurred by shoot fly (Sharma, 1993 and Kumar *et al*., 2008). As a result, genotypes widely found in the region were evaluated for shoot fly tolerance to find the most resistant genotype suiting to the local agro-climatic conditions.

Host plant resistance (HPR) is one of the most economic, compatible and practical technique for managing shoot fly and spotted stem borer damage because it does not involve any extra cost to the farmers or require application skills in pest control techniques (Sharma, 1985). The negative effects of resistant genotypes on insect populations are continuous and cumulative over time. Reduction in pest abundance through HPR can also enhance the effectiveness of natural enemies, and reduces the need to apply pesticide 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, IAVHT MC, AVHT SC and IVHT SC during *Kharif*, 2021 under natural field conditions.

MATERIALS AND METHODS

Sorghum genotypes consisted of 21 IAVHT MC, 16 AVHT SC and 25 IVHT SC including resistant (IS-18551, IS-2205 and IS-2312) and susceptible checks (DJ-6514 and Swarna), was sown in a randomized complete block design (RCBD) in three replications at the Forage Section Research Area of Department of Genetics and Plant Breeding, CCS HAU Hisar. Geographically Hisar is located at 29.1492° N, 75.7217° E coordinates from 215 m above mean sea level. Each genotype was sown in two-row of 2-m row length; the rows were 45 cm apart. The seed was sown with plough at a depth of 5 cm. Crop was sown in last mid of July, 2021 under natural conditions to study for resistance against *Atherigona soccata* Rondani and *Chilo partellus* Swinhoe. The plants were thinned 12 days after emergence to maintain a spacing of 10 cm between plants. All package and practices followed as per recommended.

Shoot Fly Damage Parameters Data were recorded on shoot fly eggs per plant at 14 DAE, and shoot fly dead hearts at 28 DAE, and expressed as number of shoot fly eggs per plant, and percentage of plants with dead hearts. Morphological Character Leaf glossiness was evaluated visually on a 1-5 scale (1 = highly glossy, and 5 = non-glossy) at 10-12 DAE (fifth leaf stage), when the expression of this trait is most apparent in the early morning hours (Sharma *et al.*, 1997). Data on numbers of plants with *C. partellus* dead hearts were recorded at 45 DAE, and expressed as percentage. Leaf feeding by *C. partellus* larvae was assessed, at 35 DAE on a 1 to 9 rating scale (1 = no visible leaf injury or a small number of pin/shot hole type of injury on a few leaves, 2 = small amount of shot hole type lesions on a few leaves, 3 = shot hole injury common on several leaves, 4 = several leaves with shot hole and elongated lesions, 5 = several leaves with elongated lesions (2.5 cm), 7 = long lesions common on about one-half of the leaves, 8 = long lesions common on about two-third of the leaves, and 9 = most leaves with long lesions) based on the type and amount of feeding (Sharma *et al.* 2024).

After subjecting the data to statistical analysis, the experimental findings are discussed here under various headings.

RESULTS AND DISCUSSION

During *Kharif* 2021, Sixty-two sorghum genotypes were sown to determine the relative resistance against the sorghum shoot fly, *A. soccata* and stem borer, *Chilo partellus* under the natural infestation conditions. The data on different morphological traits viz. leaf glossiness and seedling vigors were recorded on visual score basis. These two characters play important role in resistance against the insect pests.

Leaf Glossiness

The leaf glossiness in different sorghum genotypes were recorded at 10-12 days after germination (fifth leaf Stage) visually on a 1-5 rating and are presented in Table 1, 2 and 3. Leaf glossiness of genotypes in IAVHT MC trial *viz*. CSH 43MF, SPV 2861 and SPH 1995 was comparable to the resistant checks (IS 18551 and IS 2205). While genotype SPH 1970, SPH 1933 and Swarna were non-glossy (Table 1). However, among AVHT SC genotypes, the leaf glossiness ranged from 1.0 (SPV 2705) to 4.3 (Swarna). The lower seedling leaf glossiness score of 1.0 was observed in the resistant check IS-18551, IS 2312 at par with SPV 2885 and SPV 2878 (1.7 Glossiness Score) in table 3.

Ovipositional preference of shoot flies

The data of shoot fly eggs was recorded (shoot fly eggs per five plants basis) at 14 days after emergence. In IAVHT MC genotypes it ranged from 3.0 (IS 18551) to 11.0 (SPH 1935). The minimum eggs per five plants was laid by shoot fly on SPH 1934 (4.33) was statistically at par with Resistant check IS 2312, IS 18551 and IS 2205 (Table 1). Likewise, in AVHT SC genotype the minimum 2.3 (IS 18551) and maximum 12.3 (SPH 1985) egg laid by shoot fly per five plant were recorded (Table 2)

The data presented in Table 3 revealed that in IVHT SC tested lines, the maximum (11.3) eggs per five plants was recorded on Swarna (susceptible check) and minimum (1.3) on IS 2205(RC). The current findings were in accordance with Khandare *et al.* (2013), who found that shoot fly eggs were laid at a low level when observed 7 DAE.

Dead heart formation by Shoot Fly

The per cent dead hearts caused due to shoot fly (Fig. 1) were recorded at peak stage at 28 days after emergence (DAE) in IAVHT MC genotypes of sorghum lines differ statistically. Lowest dead hearts

TABLE 1

Screening of genotypes for insect pest resistance under IAVHT MC during *Kharif* 2021

S. No.	Entry	Shoot fly dead hearts (%) 28 DAE		SF eggs/ 5 pts		Stem borer dead hearts (%) at 45 DAE		Stem borer LIS (1-9) at 35 DAE		Seedling glossiness (1-5)	
		M	R	M	R	M	R	M	R	M	R
1.	SPH1933	51.5	17	8.33	15	24.02	13	5.0	18	4.0	20
2.	SPH1934	32.2	10	4.33	3	22.99	10	4.7	14	2.0	9
3.	SPH1935	70.6	21	11	21	26.49	16	4.3	10	4.0	17
4.	SPH1966	33.8	11	6	5	28.59	18	5.0	17	2.7	13
5.	SPH1967	46.9	14	9	16	21.54	7	4.7	13	2.7	12
6.	SPH1970	50.4	15	11	20	22.25	8	4.3	9	4.0	19
7.	SPH1993	22.8	7	7.33	12	17.35	5	4.0	6	2.0	8
8.	SPH1994	30.6	9	5.67	4	22.47	9	4.7	12	2.7	11
9.	SPH1995	21.2	6	7.33	11	23	11	4.7	11	2.0	7
10.	SPH1996	56.7	18	10.67	19	29.73	20	6.0	21	3.3	16
11.	SPH1997	35.8	12	8.33	14	23.42	12	4.3	8	3.0	14
12.	SPH1998	62.5	19	10	18	26.69	17	5.3	19	4.0	18
13.	SPV2861	25.2	8	7.67	13	17.16	3	3.0	2	2.0	6
14.	CSH 24MF	51.1	16	6.33	8	26.04	15	4.3	7	2.7	10
15.	CSV 33MF	17.0	3	7	10	30.87	21	5.0	16	3.3	15
16.	CSH 43MF	37.2	13	6.33	7	24.54	14	4.0	5	2.0	5
17.	Local Check (HJ 541)	17.7	4	6.33	6	15.71	1	5.0	15	1.3	2
18.	IS 18551 (RC)	10.9	1	3	1	15.9	2	3.0	1	1.3	1
19.	IS 2312 (RC)	13.7	2	4.33	2	17.19	4	3.7	4	2.0	4
20.	IS 2205 (RC)	19.2	5	6.33	9	17.8	6	3.3	3	2.0	3
21.	Swarna (SC)	62.7	20	9.33	17	29.08	19	5.7	20	4.3	21
	Loc. Mean	36.7		7.41		22.99		4.5		2.7	
	C.D. (p=0.05)	10.4		4.96		7.35		1.8		1.5	

TABLE 2

Screening of AVHT SC genotypes for shoot fly and stem borer resistance during *Kharif* 2021

S. No.	Entry	Shoot fly dead hearts (%) 28 DAE		SF eggs/ 5 pts		Stem borer dead hearts (%) at 45 DAE		Stem borer leaf injury score (1-9) at 35 DAE		Seedling glossiness (1-5)	
		Mean	R	Mean	R	Mean	R	Mean	R	Mean	R
1.	SPH1985	48.6	15	12.3	16	17.2	12	3.7	14	3.3	15
2.	SPV2704	18.1	5	4.7	11	14.2	4	2.7	5	1.0	2
3.	SPV2705	17.6	4	4.7	10	13.1	2	2.0	1	1.3	7
4.	SPV2797	21.7	7	5.7	13	17.0	11	2.3	3	1.3	6
5.	SPV2800	31.4	13	4.7	9	14.9	6	3.0	8	2.3	11
6.	SPV2801	31.5	14	4.7	8	13.4	3	2.7	4	3.0	14
7.	CSH36F	22.5	8	6.0	14	15.8	9	3.3	12	2.3	10
8.	CSV 30F	30.5	12	3.3	3	15.1	7	3.3	11	2.3	8
9.	CSV 35F	27.0	9	4.0	7	16.3	10	3.0	7	2.7	12
10.	CSH 40F	27.1	10	3.7	6	23.0	16	5.7	16	2.3	9
11.	CSV 21F	20.2	6	3.7	5	15.5	8	3.7	13	1.3	5
12.	Local Check (HJ 541)	28.4	11	5.7	12	19.1	14	3.3	10	1.0	1
13.	IS 18551 (RC)	14.1	1	2.3	1	11.2	1	2.3	2	1.3	4
14.	IS 2312 (RC)	16.9	3	3.7	4	17.5	13	3.3	9	2.7	13
15.	IS 2205 (RC)	14.3	2	3.0	2	14.6	5	3.0	6	1.3	3
16.	Swarna (SC)	62.7	16	8.3	15	22.5	15	5.7	15	4.3	16
	Loc. Mean	27.0		5.0		16.3		3.3		2.1	
	C.D. (p=0.05)	8.2		1.7		4.2		1.0		1.2	

TABLE 3

Screening of IVHT SC genotypes for shoot fly and stem borer resistance during *Kharif* 2021

S. No.	Entry	Shoot fly dead hearts (%) 28 DAE		SF eggs/ 5 plants		Stem borer injury score (1-9) at 35 DAE		Stem borer death hearts (%) at 45 DAE		Seedling glossiness (1-5)	
		Mean	R	Mean	R	Mean	R	Mean	R	Mean	R
1.	SPH 2006	26.2	11	2.3	9	4.3	16	17.76	16	2.0	13
2.	SPH 2007	27.4	12	3.7	15	4.0	11	17.95	17	2.0	12
3.	SPH 2008	29.3	16	3.7	14	4.0	10	17.43	15	2.3	16
4.	SPV 2878	14.3	4	3.0	12	4.0	6	13.95	3	1.7	10
5.	SPV 2879	28.9	15	7.0	23	4.7	22	18.38	19	2.0	11
6.	SPV 2880	40.3	23	6.0	22	5.7	24	22.01	23	3.0	24
7.	SPV 2881	36.5	21	4.7	18	4.0	9	14.56	4	3.0	23
8.	SPV 2882	38.9	22	5.7	21	4.7	21	20.93	21	2.3	15
9.	SPV 2883	27.7	13	5.7	20	4.3	14	16.89	13	3.0	22
10.	SPV 2884	51.2	25	8.3	24	4.3	13	19.86	20	3.0	21
11.	SPV 2885	19.0	8	2.3	8	4.7	20	17	14	1.7	9
12.	SPV 2886	18.1	7	3.7	13	4.0	8	13.89	2	2.7	17
13.	SPV 2887	25.9	10	2.3	7	4.3	12	16.33	10	2.7	20
14.	CSH 36F	28.1	14	5.7	19	4.7	19	15.1	6	2.7	19
15.	CSV 30F	30.5	17	3.0	11	4.7	18	29.24	25	1.7	8
16.	CSV 35F	31.1	18	4.7	17	4.7	17	21.37	22	2.7	18
17.	CSH 40F	31.2	19	4.7	16	4.0	7	15.69	9	2.3	14
18.	CSV 44F	17.5	6	2.3	6	3.7	5	16.46	12	1.7	7
19.	CSV38F	32.2	20	2.7	10	5.0	23	18.17	18	1.7	6
20.	CSV 21F	22.1	9	2.3	5	3.0	2	14.97	5	1.3	4
21.	Local Check (HJ 541)	16.7	5	2.3	4	3.7	4	15.45	8	1.3	3
22.	IS 18551 (RC)	12.6	1	1.7	3	3.0	1	15.39	7	1.7	5
23.	IS 2312 (RC)	12.9	2	1.3	2	4.3	15	16.43	11	1.0	2
24.	IS 2205 (RC)	13.9	3	1.3	1	3.3	3	13.32	1	1.0	1
25.	Swarna (SC)	50.0	24	11.3	25	6.7	25	24.07	24	4.3	25
	Loc. Mean	27.3		4.1		4.3		17.7		2.2	
	C.D. (5%)	9.2		3.4		1.5		5.48		1.2	

i.e. 10.9 per cent were noted in check IS-18551; which were statistically at par with those observed in IS 2312 (13.7%), CSV 33MF, local Check (17.7 %), IS-2205 (19.2%) and SPH 1995 (21.2%) to each other. The genotype SPH 1935 and susceptible check, Swarna, showed the highest dead hearts 70.6 and 62.7 per cent respectively expressing susceptibility to shoot fly (Table 1). Sharma *et al.* (2023) and Sharma *et al.*, (2024) also reported similar finding in sorghum genotypes.

Among AVHT SC and IVHT SC genotypes, the per cent of dead hearts at 28 DAE caused by shoot fly with range of 14.1 to 62.7 and 12.6 to 51.2 per cent in different lines (Table2 &3). Table 2 indicate that genotypes in AVHT SC *i.e.* SPV 2705, SPV 2704, CSV21 F and SPV 2797 having 17.6, 18.1, 20.2 and 21.7 per cent dead hearts, respectively Were at par with resistance check IS 18551 (14.1%). In IVHT SC SPV 2878 (14.3%), HJ 541 (16.7%), CSV 44 F (17.5%), SPV 2886 (18.1%), and SPV 2885 (19.0%) were at par with resistance check IS 18551 (12.6%) in shoot fly dead heart per cent (Table 3). These findings were similar to those of Arora *et al.* (2021), who reported low shoot fly dead heart incidence in the resistant genotypes ICSB 84, ICSA/B 467, ICSB 487, ICSB 14024, and IS 18551

Stem Borer Leaf Injury

The data on spotted stem borer infestation was recorded in terms of visual damage rating (1-9 scale) at 35 days after emergence (DAE). The Maximum leaf injury due to spotted stem borer was 6.7 in Swarna (Susceptible check), while minimum (2.0) in SPV 2705 (Table 1,2 &3)

Dead heart formation by Spotted Stem Borer

Among IAVHT MC genotypes, SPV 2861, SPH 1993 and SPH 1967 were good performers

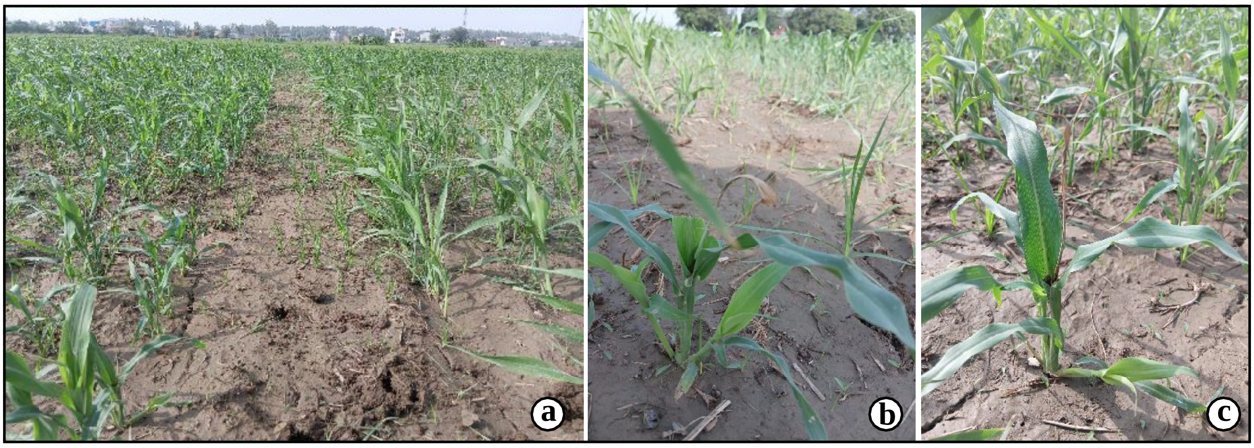

Fig. (1. a, b & c). Shoot fly infestation in sorghum.

against stem borer in terms of percent dead hearts, as the percent dead hearts were significantly lower in these genotypes and at par with all the resistance genotypes (Table 1). In Table 2, among AVHT genotypes viz. SPV 2705, SPV 2801, SPV 2704, SPV 2800 and CSV 30F were having 13.1, 13.4, 14.2, 14.9 and 15.1 per cent of dead hearts at 45 days after emergence by Spotted stem borer, which were at par with resistant check (IS 18551). Likewise, in IVHT SC trial the genotypes viz., SPV 2886, SPV 2878, SPV 2881 and CSH 36 F were at par with resistance check IS 18551 in term of dead heart caused by Spotted stem borer (Table 3).

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