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In-vivo comparison of varietal and hybrid genotype of sorghum for their reaction to the shootfly and stem borer

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Abstract
The present investigation was carried out in randomized block design during *kharif* 2016-17 at research field, AICSIP**,** College of Agriculture, Indore (MP). 50 newly developed sorghum genotypes along with two susceptible checks (DJ-6514 and SWARNA) and two resistant checks (IS 2205 and IS 18551) were tested. Shootfly damage at 14 and 28 days after emergence (DAE), leaf injury, dead hearts and stem tunneling percent by stem borer were recorded. The shootfly dead hearts at 14 DAE varied from 8.45% to 81.34% and at 28 DAE it varied from 9.30% to 82.47%. The lowest shootfly attack was recorded in both the resistant check IS 18551 and IS 2205 and in genotypes CSV 15, SPH 1848 and SPV 2324 which showed resistance while SPV 2299, SPV 2305 (SR 2872), SPV 2439, SPH 1858(SS), Swarna and DJ 6514 exhibited susceptibility. The leaf injury caused by stem borer was ranged between 1.41% to 11.16% and infestation at 45 DAE ranged from 10.07% to 55.21%. The lowest damage was recorded in resistant checks and in ICSV 25019, PVK 902 SS, SPV 2434, CSV 15, SPH 1860, SPV 2366 and SPH 1847,the stem tunneling ranged between 1.56% to 8.44% was recorded.

Keywords: Sorghum genotypes**,** Shootfly**,** Stem borer, Deadheart, leaf injury, stem tunneling

1. Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] locally known as "Jowar", is a self-pollinated crop. It belongs to Graminae (Poaceae) family and originated in North East Africa [2]. Sorghum is an important staple food crop in the world and 5th most important cereal crop after wheat, rice, maize and barley [14, 25, 26]. It is the major source of food; feed, fodder and fuel. The stem and foliage are used as green fodder, hay silage and pasture. Grain is mostly for food purpose. It is a principal feed ingredient for both cattle and poultry [11]. Sweet sorghum is being used in the preparation of syrup, jaggery, beer, bio-fuel (ethanol) etc. Major producers are the USA, Mexico, Nigeria, India, and Argentina with 11.74, 6.5, 6.5, 5.5 and 3.4 million tones production respectively [4]. In India sorghum is the third important cereal after rice and wheat, grown on average of 5.8 million ha^{-1} with the production of 5.5 million tons and productivity 926kg ha^{-1} [5]. In Madhya Pradesh sorghum crop is grown mainly in *Kharif* season and covers an area of 220 thousand hectares and production 329 thousand tones with the productivity of 1500 kg ha^{-1} respectively [6] Sorghum is cultivated in different agro ecosystems and the grain yields are influenced by various biotic and abiotic factors. Among the biotic factors, arthropods constitute a major problem to increase the sorghum production. About 150 insect species have been reported to damage sorghum in different agro-ecosystem [18]. Among them, the shootfly (*Atherigona soccata* Rondani), stem borer (*Chilo partellus* Swinhoe), ear head bug (*Calocoris angustatus* Leth.) and ear head worm (*Cryptoblebes gnidiella* Mab.) are the important insect pests attacking at different stages of the crop growth.

2. Materials and Methods

The present investigation was carried out in randomized block design during *kharif* 2016-17 at research field, AICSIP**,** College of Agriculture, Indore (MP). In this experiment 50 newly developed elite sorghum varietal and hybrid genotypes were evaluated along with two susceptible checks (DJ-6514 and SWARNA) and two resistant checks (IS 2205 and IS 18551). Observations were recorded on randomly selected 5 tagged plants for shootfly (*Atherigona soccata* Rondani) and stem borer (*Chilo partellus* Swinhoe). The analysis was carried out by adopting the method of “Analysis of variance” as suggested by Fisher and Yates, 1963 (Table 1).

Table 1: ANOVA for randomized block design

Sources of variance	Degree of freedom	Sum of square	Mean sum of square	Calculated F value	Table value at 5%
Replications	(r-1)	RSS	RMS	RMS/EMS	
Treatments	(t-1)	TrSS	TrMS	TrMS/EMS	
Error	(r-1)(t-1)	ESS	EMS		
Total	(rt-1)	TSS			

The significant differences between different treatments were judged by using critical differences (C.D.) which was calculated as follows:

$S.Em = \sqrt{EMS / r}$
$S.Ed = S.Em \times \sqrt{2}$
$C.D. = S.Ed. \times t'_{(0.05)}$
Where,
R = Number of replication, t = Number of treatments, RSS = Replication sum of square, TrSS = Treatment sum of square, ISS = Interaction sum of square, ESS = Error sum of square, TSS = Total sum of square, RMS = Replication mean sum of square, TrMS = Treatment mean sum of square, EMS = Error mean sum of square, S.Em = Standard error means, S.Ed = Standard error of differences between two treatment means, EMS = Error mean sum of square i.e. Error variance, $t'_{(0.05)}$ = Tabulated 'P' Value at error degree of freedom, at 0.05%, C.D. = Critical difference (For treatment at 5%).

3. Results and Discussion

3.1 Shootfly dead heart (SFDH) percent at 14 DAE and 28 DAE

The incidence of shootfly on sorghum was recorded on shoots at crop age of 14 and 28 days after emergence for the percent dead heart. It is revealed from data at 14 days after emergence, percent dead heart ranged from 8.45% to 81.34% in different genotypes with a significant difference. Under the resistant category of genotypes, the lowest dead heart percent caused by shootfly were found in resistant check IS 18551 (8.45%) which was at par with IS 2205 (9.55%), followed by CSV 15 (14.27%), SPH 1848 (16.54%) and SPV 2324 (18.26%). Whereas, the shoot fly susceptibility were observed in test entries SPV 2299 (53.06%), SPV 2305 (SR 2872) (63.94%), SPV 2439 (78.00%), SPH 1858(SS) (80.21%), Swarna (80.58%) and susceptible check DJ 6514(81.34%). Rest of the entries exhibited moderate resistance (Table 2). These results were more or less in accordance with the findings reported by researchers [7, 12, 19, 20, 23, 26, 28, 30] these findings are in partial agreement with the present study as these researchers did not take all the parameters for the study as it was taken in present study but as a whole looking to the screening researchers supported the present investigation.

Similarly at 28 days after emergence, percent dead heart ranged from 9.30% to 82.47%. under the resistant category of entries, the lowest dead heart percent by shootfly was found in resistant check checks IS 18551 (9.30%), which was statistically found to be at par with IS 2205 (10.64%), followed by SPH 1848 (15.56%) and CSV 15 (16.28%). Further, the shoot fly susceptibility were observed in test entries AKSV 408 (50.29%), SPH 1849 (50.56%), SPV 2431 (50.65%), SPV 2299 (52.89%), ICSV 713 (53.28%), SPV 2373 (58.24%), SPV 2305 (SR 2872) (66.53%), SPH 1858 SS (80.38%), Swarna (81.51%) SPV 2439 (82.47%) and DJ 6514 (82.52%), Swarna and DJ6514 both are susceptible checks and showed maximum shootfly incidence (Table 2). These results were more or less in accordance with the findings reported by researchers [8, 9, 15] these findings are in partial agreement with the present study as these researchers did not take all the parameters for the study as it was taken in present study but as a whole looking to the screening researchers supported the present investigation.

3.2 Stem borer incidence

Three types of observations were recorded to characterize the damage caused by stem borer *viz.*, leaf injury percent, dead heart percent and stem tunneling percent.

3.2.1 Leaf injury percent

The leaf injury by stem borer was ranged between 1.41% and 11.16%. The lowest leaf injury percent was observed in resistant check IS 2205 (1.41%) which was at par with SPV 2439 (1.46%) and resistant check IS 18551 (1.59%). Whereas, the maximum leaf injury was observed in susceptible check DJ 6514 (9.23%), SPV 2299 (9.37%) and Swarna (11.16%) (Table 3). These results were more or less in accordance with the findings reported by researchers [3, 17, 21, 22] these findings are in partial agreement with the present study as these researchers did not take all the parameters for the study as it was taken in present study but as a whole looking to the screening researchers supported the present investigation.

3.2.2 Dead heart percent

The infestation at 45 DAE was ranged from 10.07% to 55.21%. Under the resistant category of entries, the lowest damage was recorded in resistant check IS 18551 (10.07%), which was at par with IS 2205 (11.45%) followed by ICSV 25019 (14.23%), PVK 902 SS (14.76%), SPV 2434 (16.53%), CSV 15 (17.28%), SPH 1860 (17.95%), SPV 2366 (19.30%) and SPH 1847 (19.56%). Further, the susceptibility were recorded in test entries SPV 2293 (30.24%), which was statistically at par with SPV 2432 (30.62%), followed by SPH 1779 (34.52%), SPV 2435 (35.22%), CSV 20 (35.62%), IS 2146 (37.03%), IS 2123 (37.14%), SPV 2358 (37.47%), SPV 2372 (37.51%), SPH 1858 SS (38.12%), SPV 2440 (38.31%), Swarna (50.51%), SPV 2308 (51.29%) and DJ 6514 (55.21%). Rest of the entries exhibited moderate resistance against the insect (Table 3). These results were more or less in accordance with the findings reported by researchers [3, 13, 17, 26, 27, 30] these findings are in partial agreement with the present study as these researchers did not take all the parameters for the study as it was taken in present study but as a whole looking to the screening researchers supported the present investigation.

3.2.3 Stem tunneling percent

The stem tunneling percent ranged from 1.56% and 8.44%. The least dead heart percent was noticed in resistant check IS 2205 (1.56%) found to be at par with resistant check IS 18551(1.63%), Whereas, the maximum stem tunneling was recorded in SPV 2299 (7.12%), susceptible check DJ 6514 (7.64%) and Swarna (8.44%). Finally, all the entries exhibited resistance to the stem borer (Table 3) which is in accordance with researchers [1, 3, 11, 17, 16, 29] these findings are in partial agreement with the present study as these researchers did not take all the parameters for the study as it was taken in present study but as a whole looking to the screening researchers supported the present investigation.

Table 1: Sorghum genotypes as influenced by shootfly dead heart (%)

S.N.	Entry	14 DAE		28 DAE	
		OV	TV*	OV	TV*
1	AKSV 410	29.25	32.74	30.61	33.59
2	PVK 1014	38.23	38.19	42.70	40.80
3	PVK 902 SS	47.74	43.71	49.65	44.80
4	RSSV 350	46.16	42.80	47.39	43.51
5	SPV 2299	53.06	46.76	52.89	46.66
6	SPV 2305 (SR 2872)	63.94	53.10	66.53	54.65
7	SPV 2431	47.17	43.38	50.65	45.37
8	SPV 2432	38.28	38.22	39.61	39.01
9	SPV 2433	46.40	42.94	46.54	43.01
10	SPV 2434	42.26	40.55	43.46	41.24
11	SPV 2435	38.21	38.18	40.42	39.48
12	SPV 2436	28.68	32.38	29.37	32.82
13	SPV 2437	35.35	36.48	36.36	37.08
14	SPV 2439	78.00	62.05	82.47	65.25
15	SPV 2293	38.57	38.39	39.45	38.91
16	SPV 2363	40.09	39.28	43.29	41.14
17	SPV 2364	43.38	41.19	45.53	42.44
18	SPV 2366	45.30	42.30	48.16	43.94
19	SPV 2372	47.30	43.45	49.38	44.64
20	SPV 2373	54.01	47.30	58.24	49.74
21	CSV 27	33.87	35.58	36.46	37.15
22	SPH1858(SS)	80.21	63.59	80.38	63.71
23	SPH1860	30.38	33.45	31.28	34.01
24	SPH1862	40.28	39.39	40.26	39.39
25	SPV2324	18.26	25.29	20.20	26.71
26	SPH 1847	22.57	28.36	23.39	28.92
27	SPH 1848	16.54	23.99	15.56	23.23
28	SPH 1849	49.29	44.59	50.56	45.32
29	ICSV 713	49.62	44.78	53.28	46.88
30	ICSV 25019	48.18	43.96	49.46	44.69
31	IS 2123	36.22	37.00	37.32	37.65
32	IS 2146	35.18	36.38	36.84	37.37
33	SPH 1778	22.88	28.55	24.46	29.64
34	SPH 1779	37.15	37.55	39.73	39.07
35	SPH 1789	29.43	32.85	31.69	34.26
36	AKSV 408	49.27	44.58	50.29	45.16
37	RSSV 397	46.61	43.05	44.61	41.91
38	S- 652	47.32	43.46	47.70	43.68
39	SPV 2296	48.94	44.39	49.57	44.76
40	SPV 2308	38.81	38.53	40.33	39.43
41	SPV 2358	41.18	39.92	42.38	40.62
42	SPV 2426	21.96	27.94	26.04	30.68
43	SPV 2438	35.62	36.64	38.53	38.37
44	SPV 2440	45.61	42.48	47.60	43.63
45	CSV 20	32.19	34.57	33.46	35.34
46	IS 18551	8.45	16.90	9.30	17.75
47	IS 2205	9.55	18.00	10.64	19.04
48	DJ 6514	81.34	64.41	82.52	65.66
49	Swarna	80.58	63.85	81.51	64.53
50	CSV 15	14.27	22.15	16.28	23.80
	S.Em. ±	0.47		0.54	
	C.D. at 5%	1.33		1.51	
	CV %	13.05		14.60	

Values are arc sin transformation value

Table 3: Sorghum genotypes as influenced by Stem borer attack (%)

S. N.	Entry	Leaf injury		Dead heart		Stem tunneling	
		OV	TV*	OV	TV*	OV	TV*
1	AKSV 410	3.51	10.80	25.30	30.20	3.67	11.04
2	PVK 1014	6.54	14.82	26.79	31.16	4.43	12.14
3	PVK 902 SS	2.50	9.08	14.76	22.56	5.50	13.53
4	RSSV 350	8.02	16.45	29.42	32.85	3.31	10.48
5	SPV 2299	9.37	17.82	26.22	30.80	7.12	15.48
6	SPV 2305 (SR 2872)	2.36	8.82	23.17	28.77	6.56	14.84
7	SPV 2431	5.73	13.85	26.64	31.07	4.40	12.10
8	SPV 2432	3.66	11.03	30.62	33.53	3.52	10.80
9	SPV 2433	7.18	15.54	27.05	31.34	2.47	9.04
10	SPV 2434	2.74	9.53	16.53	23.99	2.20	8.52
11	SPV 2435	3.47	10.73	35.22	36.40	3.48	10.74
12	SPV 2436	2.63	9.31	28.67	32.37	3.60	10.92
13	SPV 2437	3.45	10.70	21.30	27.49	2.45	8.99
14	SPV 2439	1.46	6.91	21.36	27.53	3.44	10.69
15	SPV 2293	3.98	11.48	30.24	33.36	4.20	11.82
16	SPV 2363	6.41	14.67	22.35	28.21	3.31	10.47
17	SPV 2364	4.27	11.92	20.33	26.80	6.82	15.14
18	SPV 2366	4.28	11.93	19.30	26.06	4.57	12.34
19	SPV 2372	5.23	13.22	37.51	37.76	2.29	8.68
20	SPV 2373	5.00	12.82	20.18	26.70	5.68	13.79
21	CSV 27	4.70	12.27	26.63	31.07	5.44	13.48
22	SPH1858(SS)	6.34	14.58	38.12	38.13	5.74	13.86
23	SPH1860	6.55	14.83	17.95	25.06	4.42	12.14
24	SPH1862	5.42	13.46	23.42	28.94	4.42	12.13
25	SPV2324	7.08	15.43	20.37	26.83	3.78	11.20
26	SPH 1847	3.89	11.35	19.56	26.25	2.48	9.06
27	SPH 1848	7.44	15.83	26.27	30.83	2.66	9.37
28	SPH 1849	5.29	13.29	29.35	32.80	3.57	10.89
29	ICSV 713	5.10	13.06	22.42	28.25	2.55	9.19
30	ICSV 25019	2.06	8.25	14.23	22.10	2.47	9.04
31	IS 2123	3.14	10.20	37.14	37.55	2.49	9.06
32	IS 2146	5.10	13.05	37.03	37.48	2.29	8.70
33	SPH 1778	4.42	12.14	21.51	27.63	3.17	10.25
34	SPH 1779	3.30	10.47	34.52	35.98	2.38	8.86
35	SPH 1789	4.33	12.01	29.51	32.91	2.43	8.96
36	AKSV 408	3.66	11.03	27.50	31.63	3.62	10.96
37	RSSV 397	4.85	12.72	25.35	30.23	4.23	11.86
38	S- 652	3.45	10.69	26.89	30.94	3.52	10.81
39	SPV 2296	4.43	12.15	29.43	32.65	3.63	10.98
40	SPV 2308	3.79	11.22	51.29	45.74	5.55	13.62
41	SPV 2358	6.48	14.75	37.47	37.75	4.31	11.98
42	SPV 2426	5.53	13.59	24.52	29.68	2.69	9.43
43	SPV 2438	3.70	11.09	28.58	32.32	3.53	10.82
44	SPV 2440	5.41	13.44	38.31	38.24	4.60	12.38
45	CSV 20	4.54	12.30	35.62	36.64	5.54	13.61
46	IS 18551	1.59	7.24	10.07	18.50	1.63	7.32
47	IS 2205	1.41	6.79	11.45	19.77	1.56	7.12
48	DJ 6514	9.23	17.68	55.21	47.99	7.64	16.05
49	Swarna	11.16	19.51	50.51	45.29	8.44	16.89
50	CSV 15	4.42	12.14	17.28	24.57	4.44	12.16
	S.Em. ±	0.39		0.92		0.27	
	C.D. at 5%	1.10		2.57		0.76	
	CV %	19.34		28.36		13.97	

Values are arc sin transformation value

4. Conclusion

The incidence of shootfly on sorghum was recorded on shoots at crop age of 14 and 28 days after emergence for the percent dead heart. It was found that the lowest shoot fly attack was recorded in both the resistant check IS 18551 and IS 2205 among the entries CSV 15, SPH 1848 and SPV 2324 found resistant to shootfly incidence. While SPV 2299, SPV 2305 (SR 2872), SPV 2439, SPH 1858(SS), susceptible check Swarna and DJ 6514 was found susceptible to shootfly incidence.

The leaf injury by stem borer was ranged from 1.41% to 11.16%. The lowest leaf injury percent was observed in resistant check IS 2205 (1.41%). Whereas, the maximum leaf injury was observed in susceptible check Swarna (11.16%). At 45 DAE the lowest damage was recorded in resistant check IS 18551 and IS 2205 among the entries ICSV 25019, PVK 902 SS, SPV 2434, CSV 15, SPH 1860, SPV 2366 and SPH 1847 found resistant against stem borer incidence. However, maximum dead heart percent was recorded in susceptible check DJ 6514.The stem tunneling percent ranged from 1.56% and 8.44%. The least dead heart percent was noticed in resistant check IS 2205 whereas, the maximum stem tunneling was recorded Swarna (8.44%).

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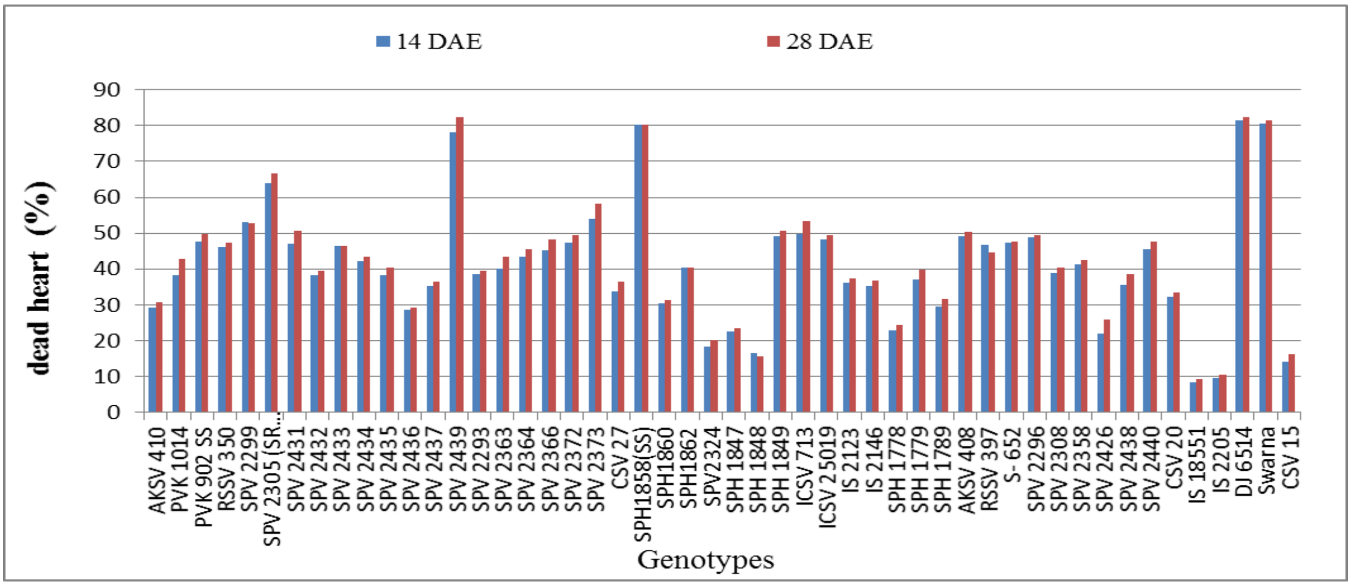

Fig 1: Reaction of sorghum genotypes against shootfly

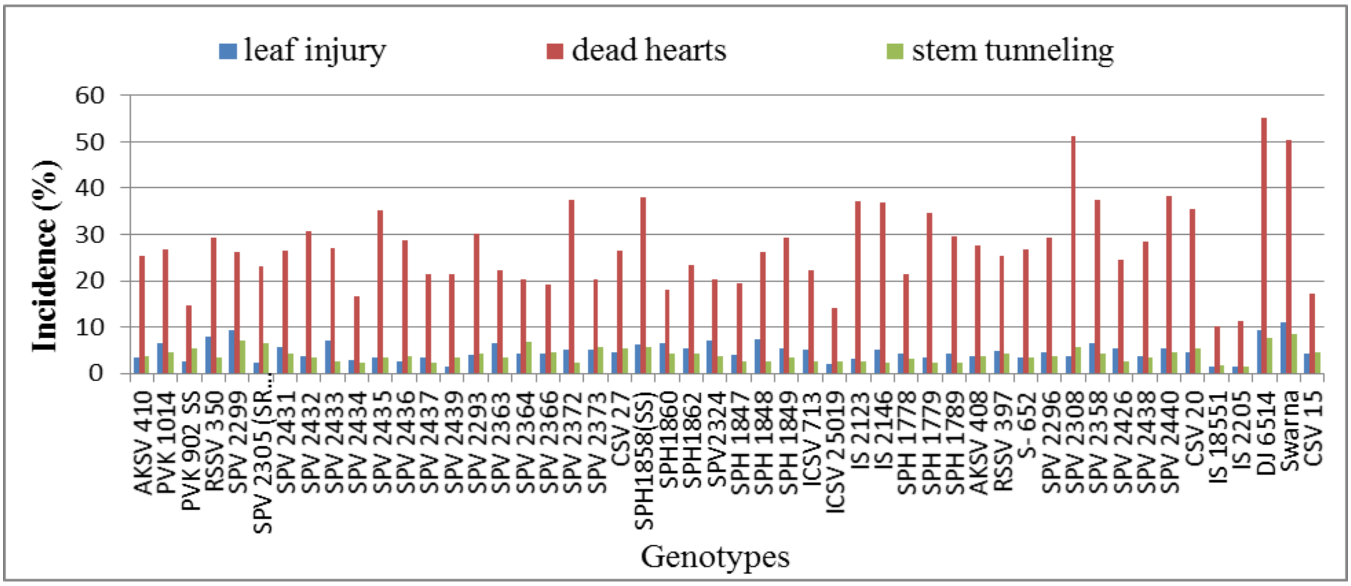

Fig 2: Reaction of sorghum genotypes against stem borer incidence

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