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Screening of Sorghum Genotypes Against Shoot Fly and Stem Borer

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ABSTRACT

A field experiment was carried out to screen the sorghum genotypes against shoot fly in rice fallow under zero tillage condition. A total of 30 genotypes were evaluated for shoot fly tolerance interms of dead hearts using 1-9 scale, eleven were found to be resistant, eighteen genotypes were moderately resistant with scale 5 and one genotype was found to be susceptible under scale-7. The highest number of trichomes were recorded in the resistant genotypes CSV 14 R (177), followed by CSH 30 (164), CSV 29R (154), CSV 26 (153), NTJ-1 (C) (147) and CSV 22 (145) which resulted in 10.13 to 14.50% dead hearts. There was a significant negative correlation between the shoot fly per cent dead hearts and trichomes on adaxial surface and abaxial surface while, the correlation was positive with leaf glossiness and yield. Based on mean stem tunnel length, the genotypes were categorized as least susceptible (0-5 cm), moderately susceptible (5-10 cm) and highly susceptible (>10 cm). The resistant check CSH 16 (C) was found to be least susceptible with 4.65 cm mean stunnel length, whereas, NTJ-2 (C), NLCW-6 and N-14 were found to be highly susceptible as they recorded 10.45, 10.46 and 11.44 cm respectively. The remaining genotypes were found to be moderately susceptible with 6.60 to 9.84 cm as mean stem tunnel length.

Key words : *Dead hearts, Mean stem tunnel length, Shoot fly, Stem borer.*

Sorghum [*Sorghum bicolor* (L.) Moench] is the fifth major cereal crop after wheat, rice, maize and barley. It is the most important crop of Asia, Africa, Australia, America and is cultivated as a staple crop in the semi-arid tropics (SAT). The yield penalties to sorghum are very high starting from seedling stage to harvest, and are allotted maximally to biotic stresses. More than 150 species of insects have been recorded as pests of sorghum, of which sorghum shoot fly, *Atherigona soccata* (Rondani) and stem borer, *Chilo partellus* (Swinhoe) are important insect pests in Asia, Africa, and the Mediterranean and Europe. Insect pests cause nearly 32% of the total loss to the actual produce in India (Borad & Mittal, 1983), 20% in Africa and Latin America, 9% in USA. In India, it is cultivated in an area of 6.18 m ha with 5.33 million tonnes production and productivity of 863 kg/ha (Agricultural Census, 2013).

In general sorghum is cultivated during *kharif,* maghi (Late *kharif*) and *rabi* seasons in Andhra Pradesh in an area of 2,87,000 ha with production of 5,46,000 tonnes and productivity of 1904 kg/ha (Agricultural Statistics at a glance, 2012-2013) as against normal area of 7,60,000 ha with production of 5,52,000 tonnes and productivity of 730 kg/ha. The reasons for low productivity under normal type of cultivation might be due to shifting of jowar area to cultivation of commercial crops, high humidity in coastal regions and ravage of pests and diseases in jowar cultivating areas. Losses in sorghum due to insect pests differ in magnitude on a regional basis and have been estimated at US $ 1089 million in the SAT, US $ 250 million in USA and US $ 80 million in Australia (Anonymous, 1992). Among the insect pests, shoot fly, *Atherigona soccata* (Rondani) and stem borer, *Chilo partellus* (Swinhoe) are the major threats with 75.6% and 24.3 to 36.3% yield losses respectively (Pawar *et al.*, 1984).

Subbarayudu *et al.* (2011) evaluated 27 sorghum genotypes against shoot fly and stem borer and reported that seven genotypes *viz.*, SR 770-2, SR 970-2, SR 833, GFS 261, ICSV 745, IS2312 and IS 2205 were resistant, while 15 genotypes *viz.*, SR 1247-1, SR 2126, ICSV 705, SPV 839, CSV 15, SR 2135, RS 29, CSH 5, GSSV 251, NSS 103, SR 1115-1, CSH 6, CSH 9, SPV 462 and IS 19349 were moderately resistant and five genotypes *viz.*, SR 1645, DJ 6514, NSS 104, 296B and IS 4332 were susceptible. The effect of resistant genotypes on insect population is continuous and cumulative over time. Umakanth *et al*. (2004) reported 'SPV 1022', 'PKV809' and 'CO28' as promising sorghum cultivars in rice-fallows. Hence, it is needed to identify the resistance sources against sorghum shoot fly and stem borer along with high yielding genotypes.

MATERIAL AND METHODS

"Screening of sorghum genotypes against shoot fly and stem borer" was carried out during *rabi,* 2014-15 in the southern block of Agricultural College Farm, Bapatla. Investigation was carried out to screen the sorghum genotypes against shoot fly in rice fallow under zero tillage condition. Twenty genotypes procured from Indian Institute of Sorghum Research, Hyderabad and Regional Agricultural Research Station (R.A.R.S), Nandyal were used as source material for the screening study. The experiment was laid out in Randomized Block Design at Agricultural college Farm, Bapatla and the treatments were replicated twice. The crop was sown on 7-1-2015. The length of each line was 4 m and spacing between two lines of each genotype was 45 cm and intra row spacing adopted was 15 cm.

Observations were recorded starting from 7 days after emergence (DAE) of seedlings and continued up to 35 days. In both the rows total number of dead hearts were counted and percentage of dead hearts was calculated as per the given formula given below

$$\text{Dead hearts (\%)} = \frac{\text{No. of plants with dead hearts}}{\text{Total no. of plants observed}} \times 100$$

Based on 1-9 scale the 30 genotypes were categorized as follows (Gomashe *et al*., 2010).

Scale	% infestation	Reaction
1	≤ 10% infestation	Highly resistant
3	10 to 20%	Resistant
5	20 to 35%	Moderately resistant
7	35 to 50% infestation	Susceptible
9	≥ 50% infestation	Highly susceptible

Trichome density

Three seedlings from each genotype were selected randomly and the presence and density of trichomes was measured on the central portion of the 5th leaf (from the base). For this purpose, leaf pieces (2 sq.cm) taken from the central portion of the leaf were placed in acetic acid and alcohol mix (2:1) in stoppered glass vials (10 ml capacity) for 24 h to clear the chlorophyll, and subsequently transferred into lactic acid (90%) as a preservative (Maiti and Bidinger, 1979). The leaf sections were mounted on a glass slide in a drop of lactic acid, and magnified at 10X under a stereo-microscope. The trichomes on leaf surfaces, both abaxial and adaxial surfaces, were expressed as number of trichomes per 10X microscopic field. The images were taken with the help of tablet microscope digital camera at Department of Genetics and Plant Breeding, Agricultural College, Bapatla.

Leaf glossiness

The leaf glossiness was evaluated on a 1 to 5 rating scale at 10 DAE in the morning hours, when there was maximum reflection of light from the leaf surfaces (1= highly glossy- light green, shiny, narrow, and erect leaves; 5= non-glossy- dark green, dull, broad, and drooping leaves) (Dhillon *et al*., 2005).

Observations were recorded on dead hearts caused by *C. partellus* (number of plants with dead heart symptoms and total number of plants were recorded from each plot based on which per cent dead hearts was calculated from 30 DAS to 60 DAS at weekly intervals), per cent damaged leaves (number of leaves with leaf injury symptoms like scraping, shot holes and total number of leaves were recorded from each plot based on which per cent leaf injury was calculated from 30 DAS to 60 DAS at weekly intervals). Damage caused by *C. partellus* in tillers (damaged tillers and total number of tillers per hill were recorded and per cent tiller damage was calculated) and stem tunneling (at the time of harvesting, by destructive sampling, the main stem of plants infested with *C. partellus* was split open from the base to the apex, and the cumulative tunnel length and stem length was measured in centimeters).

The percentage tunneling was calculated using the formula given below.

$$\frac{\text{Length of tunneling (cm)}}{\text{Total length of stem (cm)}} \times 100$$

No. of white ears per plot (Number of white ears due to stem borer infestation per plot from the total number of plants sampled was

Table 1. Morphometric charecters and Performance of sorghum genotypes resistant to shoot fly *Atherigona soccata* during rabi, 2014-15.

S. No.	Genotype	% of Dead hearts caused by shoot fly	No. of Trichomes on Adaxial surface	No. of Trichomes on Abaxial surface	Glossiness	Reaction	Grain yield	Fodder yield
1	CSV 14R	10.13	177	101	1.15	R	3306	10139
2	CSV 29R	10.66	154	103	2.00	R	4333	7972
3	CSV 26	11.06	153	100	1.70	R	4472	11528
4	CSH 30	11.42	164	97	3.70	R	5417	7222
5	NTJ-1 (C)	12.09	147	102	1.80	R	4056	7778
6	CSV 22	14.50	145	107	3.70	R	4389	9167
7	CSH 13	14.82	145	113	2.05	R	4861	13056
8	CSV 17	16.01	145	90	2.05	R	4611	4694
9	CSH 24MF	18.11	143	94	2.95	R	4417	5306
10	NLCW-12	19.79	138	93	2	R	3361	5111
11	CSH 16 (C)	20.00	122	91	1.55	R	3389	5611
12	NTJ-3 (C)	21.96	114	66	1.75	MR	4444	9167
13	Mahalaxmi 296 (C)	26.00	99	74	3.90	MR	4250	8417
14	NTJ-2 (C)	28.89	2	2	2.10	MR	4417	7500
15	NTJ-4 (C)	30.30	2	2	2.90	MR	4167	6667
16	CSH 20MF	35.58	0.00	0.00	3.10	S	6250	8750

Table 2. Morphometric charecters and Performance of sorghum genotypes moderately resistant to shoot fly, Atherigona *soccata*, during rabi, 2014-15.

S. No.	Genotype	% of Dead hearts caused by shoot fly	Trichomes on Adaxial surface(No. per unit area)	Trichomes on Abaxial surface	Glossiness	Reaction	Grain yield	Fodder yield
1	NTJ-1 (C)	12.09	147	102	1.80	R	4056	7778
2	CSH 25	20.51	125	67	1.70	MR	5278	5972
3	CSH 16 (C)	20.60	122	91	1.55	R	3389	5611
4	CSH 14	21.25	119	76	1.55	MR	3833	8222
5	NLCW-6	21.28	124	82	1.90	MR	5000	6833
6	NTJ-3 (C)	21.96	114	66	1.75	MR	4444	9167
7	NLCW-8	22.66	145	90	1.75	MR	4556	7306
8	CSV 23	25.67	86	31	3.30	MR	4500	6111
9	BRJ-358	25.91	109	82	2.20	MR	4417	8750
10	Mahalaxmi 296 (C)	26.00	99	74	3.90	MR	4250	8417
11	N-14	26.19	111	69	1.50	MR	3861	5000
12	SSV 84	26.92	35	15	1.80	MR	3528	4333
13	N-13	27.22	83	34	1.80	MR	3972	6528
14	CSV 216R	27.57	23	17	1.70	MR	4917	11250
15	CSV 24SS	27.81	8	20	2.20	MR	2778	4500
16	CSH 22SS	28.58	2	2	4.10	MR	5278	8194
17	CSV 15	28.58	3	2	2.05	MR	3778	10333
18	NTJ-2 (C)	28.89	2	2	2.10	MR	4417	7500
19	NTJ-4 (C)	30.30	2	2	2.90	MR	4167	6667
20	CSH 23	32.91	0	0	1.40	MR	5833	9306

Genotypes were categorized based on stem tunneling as per Rajasekhar and Srivastav (2013).

S. No.	Range of mean tunnel length (cm)	Attribute
1	0-5	Least susceptible
2	5-10	Moderately Susceptible
3	>10	Highly Susceptible

recorded and the percentage white ears was calculated) and chaffy grain percentage (The total number of grains from each ear head and the chaffy or under developed grains in randomly selected 5 ear heads from each plot were counted and the per cent chaffy grain was calculated)) were recorded.

Yield attributes like no. of tillers per plant (number of tillers per plant by measuring the number of side tillers produced per plant from five randomly selected plants from each plot), days to 50% flowering (the number of days from date of sowing to the stage when 50 per cent of the plants emerged ear heads in each plot) plant height (cm) (the mean plant height was recorded by measuring from the base of the plant to the tip of the growing point at the time of harvest and expressed as plant height in centimeter (cm)), grain yield (after threshing and winnowing the ear heads of the genotypes, the grains were weighed and grain yield per plot was recorded and expressed as kg per plot and then extrapolated to kgha-1) and fodder yield (after harvesting of ear heads the completely sundried stovers were weighed and recorded the fodder yield and expressed as kg per plot and then extrapolated to kgha-1) were recorded.

RESULTS AND DISCUSSION

Among the thirty screened sorghum genotypes screened, eleven were found as resistant when compared to the popular local check, Mahalaxmi 296, which was moderately resistant (Table 1). Among the resistant genotypes, CSV 14R, CSV 29R, CSV 26 and CSH 30, CSV 22, CSH 13, CSV 17, CSH 24MF, NLCW-12 were at par with the resistant check NTJ-1 but significantly differed from the moderately resistant popular local check Mahalaxmi 296 and others.

Among the resistant genotypes, CSH 30 was found to be glossy with medium plant height and duration which recorded significantly higher grain yield and moderate fodder yield when compared to others.

The genotype CSH 20MF was observed to be non-glossy, free of trichomes, medium plant height and duration and was found to be susceptible to shoot fly recorded significantly highest yield compared to the remaining genotypes. The reasons for high yield might be due to the presence of bio-chemical factors.

The fourteen genotypes were grouped under moderately resistant to shoot fly (Table 2). Among these, the genotypes CSH 23 (free of trichomes, glossy in nature, early durated, medium plant height), CSH 25 (medium plant height & duration, more number of trichomes on adaxial surface with glossiness), CSH 22SS (very lesser number of trichomes on both sides, non-glossy, late durated, medium plant height) significantly recorded higher grain yields with moderate fodder yields.

Hence, these genotypes can be utilized for resistant breeding programmes and can be recommended for the cultivation under zero tillage in rice fallows.

Among the 30 screened genotypes, 22 genotypes and the popular check Mahalaxmi 296, NTJ-1, NTJ-4 and NTJ-3 were grouped as moderately susceptible (Table 3) to stem borer when compared to the least susceptible resistant check CSH 16 and highly susceptible check NTJ-2, N-14 and NLCW-6 (Table 4).

Reaction of Sorghum Genotypes to Both Shoot fly and Stem borer

The genotypes CSV 14R, CSV 29R, CSV 26, CSH 30, CSV 22, CSH 13, CSV 17, CSH 24 MF and NLCW-12 exhibited resistant reaction to shoot fly but moderate susceptibility to stem borer (Table 5), whereas, NLCW-6 and NLCW-12 which were found to be moderately resistant to shoot fly were highly susceptible to stem borer and were at par with susceptible check, NTJ-2.

From the above observations, the performance of the sorghum genotypes under zero tillage condition in rice fallows was analysed quantitatively and qualitatively. The late flowering genotypes CSV 22 (non-glossy), CSV 26 (glossy) and CSH 13 (non- glossy) with more number of trichomes on both abaxial and adaxial surfaces of

Table 3. Performance of sorghum genotypes moderately susceptible to stem borer, *Chilo partellus* during rabi, 2014-15.

S. No.	Genotype	% dead hearts	% damaged leaves	% tiller damage	Mean stem tunnel length (cm)	Reaction	% white ears	Mean chaffy grain percent-age (%)	No of tillers/ plant	Days to 50% flowering	Plant height (cm)	Grain yield	Fodder yield
1	CSH 16 (C)	3.23	8.04	40.74	4.65	LS	14.49	11.25	5.40	69	132.45	3389	5611
2	CSH 24MF	4.92	6.96	36.92	6.10	MS	8.50	13.64	6.50	62	172.55	4417	5306
3	CSV 26	0.00	12.22	41.38	6.60	MS	7.57	7.28	5.80	76	195.20	4472	11528
4	NLCW-12	0.00	5.18	36.36	7.80	MS	13.39	18.00	6.60	73	100.00	3361	5111
5	CSH 23	0.00	12.34	39.71	7.83	MS	0.00	15.45	6.80	63	151.60	5833	9306
6	CSV 15	1.92	12.80	45.10	8.07	MS	8.30	9.36	5.10	72	159.35	3778	10333
7	CSH 14	4.42	13.51	36.84	8.34	MS	6.35	9.60	5.70	58	156.80	3833	8222
8	CSV 17	1.96	6.79	38.33	8.37	MS	4.98	13.33	6.00	65	98.10	4611	4694
9	CSV 22	4.66	14.15	40.00	8.57	MS	9.88	8.67	4.00	77	195.00	4389	9167
10	NTJ-1 (C)	2.44	7.78	30.77	8.58	MS	10.43	5.00	5.20	70	130.05	4056	7778
11	CSV 14R	3.56	10.42	43.48	8.60	MS	8.85	19.17	4.60	61	191.20	3306	10139
12	CSH 30	0.00	9.46	31.82	8.65	MS	4.13	12.50	6.60	71	148.25	5417	7222
13	CSV 24SS	3.41	18.21	39.22	8.78	MS	10.90	8.33	5.10	71	158.00	2778	4500
14	CSV 216R	5.59	16.71	36.00	8.87	MS	3.27	8.57	5.00	66	202.15	4917	11250
15	CSH 20MF	1.00	11.37	36.92	8.98	MS	0.00	12.50	6.50	66	175.30	6250	8750
16	N-13	4.37	4.11	41.67	8.98	MS	5.53	10.00	6.00	72	179.30	3972	6528
17	CSV 23	1.96	8.97	35.09	9.13	MS	6.92	15.45	5.70	85	159.85	4500	6111
18	CSH 13	1.04	14.19	35.85	9.14	MS	4.97	9.58	5.30	80	207.00	4861	13056
19	CSV 29R	3.36	9.80	42.86	9.19	MS	6.71	6.53	5.60	70	193.15	4333	7972
20	NTJ-4 (C)	2.27	11.25	39.42	9.32	MS	7.88	9.58	6.30	71	188.45	4167	6667
21	SSV 84	0.96	18.87	38.46	9.35	MS	8.65	5.42	6.50	78	161.00	3528	4333
22	CSH 22SS	1.96	15.36	42.86	9.45	MS	4.88	8.12	5.60	82	197.45	5278	8194
23	CSH 25	1.00	11.53	43.10	9.48	MS	3.13	7.93	5.80	72	170.80	5278	5972
24	BRJ-358	0.00	5.36	40.32	9.50	MS	10.09	40.00	6.20	80	174.05	4417	8750
25	NTJ-3 (C)	1.04	9.76	38.78	9.52	MS	5.05	12.94	4.90	70	224.75	4444	9167
26	NLCW-8	4.71	9.44	35.48	9.60	MS	8.37	22.86	6.20	75	128.95	4556	7306
27	Mahalami 296 (C)	1.02	18.17	43.40	9.84	MS	8.89	10.83	5.30	65	145.00	4250	8417
28	NTJ-2 (C)	0.00	9.11	37.21	10.45	HS	7.26	7.27	4.30	75	181.20	4417	7500

Table 4. Performance of sorghum genotypes susceptible to stem borer, , *Chilo partellus* during rabi, 2014-15.

S. No.	Genotype	% dead hearts	% damaged leaves	% tiller damage	Mean stem tunnel length (cm)	Reaction	% white ears	Mean chaffy grain percent-age (%)	No of tillers/ plant	Days to 50% flowering	Plant height (cm)	Grain yield	Fodder yield
1	CSH16 (C)	3.23	8.04	40.74	4.65	LS	14.49	11.25	5.40	69	132.45	3389	5611
2	NTJ-1 (C)	2.44	7.78	30.77	8.58	MS	10.43	5.00	5.20	70	130.05	4056	7778
3	NTJ-4 (C)	2.27	11.25	39.42	9.32	MS	7.88	9.58	6.30	71	188.45	4167	6667
4	NTJ-3 (C)	1.04	9.76	38.78	9.52	MS	5.05	12.94	4.90	70	224.75	4444	9167
5	Mahalami 296 (C)	1.02	18.17	43.40	9.84	MS	8.89	10.83	5.30	65	145.00	4250	8417
6	NTJ-2 (C)	0.00	9.11	37.21	10.45	HS	7.26	7.27	4.30	75	181.20	4417	7500
7	NLCW-6	0.00	6.94	35.71	10.46	HS	5.51	13.75	2.00	72	111.60	5000	6833
8	N-14	1.02	4.11	39.66	11.44	HS	7.65	9.56	5.80	71	170.75	3861	5000
9	CSH 20MF	1.00	11.37	36.92	8.98	MS	0.00	12.50	6.50	66	175.30	6250	8750

leaf having medium plant height, semi loose and broader at upper type panicles, greyed white seed with moderate grain but higher fodder yielders were resistant to shoot fly and moderately susceptible to stem borer.

The resistant genotype CSH 30 was non-glossy, more number of trichomes on both surfaces, medium durated, short plant height, semi-compact and symmetrical type of panicle with greyed white seed recorded higher grain and moderate fodder yields.

The non-glossy, greyed white seeded CSV 29R genotype was resistant to shoot fly but moderately susceptible to stem borer having medium duration, with more number of trichomes on both surfaces, medium plant height and moderate grain and fodder yielders with symmetric and semi compact type panicles.

All the above resistant genotypes were on par with the resistant checks, NTJ-1 and CSH-16 (which recorded medium duration, short plant height, glossy in nature with more number of trichomes on both the surfaces) and moderately resistant popular local check Mahalaxmi 296, which was early durated, short plant height and non-glossy with average number of trichomes on both surfaces, semi-loose and symmetrical type of panicles with white seed.

The non-glossy white seeded moderately resistant checks, NTJ-2 and NTJ-4 were medium durated, medium plant height with semi-compact, broad upper type of panicles. The glossy genotypes, N-14 and NLCW-12 (C) were moderately resistant to shoot fly but highly susceptible to stem borer were with average number of trichomes on both surfaces, medium duration, plant height and moderate yields.

The non-glossy, non-trichomed yellow-white seeded genotype CSH 20MF, with medium duration with medium plant height, more number of tillers, semi compact and symmetric type panicles, though it was found to be highly susceptible to shoot fly gave higher yields.

The infestation in terms of dead hearts caused by shoot fly ranged from 0.10 to 35.58%. As per 1-9 scale, for shoot fly infestation interms of dead hearts among the 30 evaluated genotypes, eleven namely CSH 16 (C), CSH 24MF, CSV 17, CSV 22, CSV 26, CSV 29R, CSH 30, CSH 14R, CSH 13, NTJ-1 (C) and NLCW-12 were found to be resistant, eighteen genotypes including popular local check Mahalaxmi 296, CSV 24SS, CSH 22SS, CSV 23, SSV 84, CSV 216R, CSV 15, CSH 14,

Table 5. The reaction of sorghum genotypes against shoot fly and stem borer during rabi, 2014-15.

S. No.	Genotype	Shoot fly infestation		Stem borer infestation		Yield	
		% Dead hearts	Reaction	Stem tunnel length (cm)	Reaction	Grain	Fodder
1	CSV 24SS	27.81	MR	8.78	MS	2778	4500
2	CSH 22SS	28.58	MR	9.45	MS	5278	8194
3	CSV 23	25.67	MR	9.13	MS	4500	6111
4	CSH 20MF	35.58	S	8.98	MS	6250	8750
5	CSH 24MF	18.11	R	6.10	MS	4417	5306
6	CSV 17	16.01	R	8.37	MS	4611	4694
7	SSV 84	26.92	MR	9.35	MS	3528	4333
8	CSV 216R	27.57	MR	8.87	MS	4917	11250
9	CSV 15	28.58	MR	8.07	MS	3778	10333
10	CSH 14	21.25	MR	8.34	MS	3833	8222
11	CSV 22	14.50	R	8.57	MS	4389	9167
12	CSV 26	11.06	R	6.60	MS	4472	11528
13	CSH 23	32.91	MR	7.83	MS	5833	9306
14	CSV 29R	10.66	R	9.19	MS	4333	7972
15	CSH 30	11.42	R	8.65	MS	5417	7222
16	CSV 14R	10.13	R	8.60	MS	3306	10139
17	CSH 13	14.82	R	9.14	MS	4861	13056
18	CSH 25	20.51	MR	9.48	MS	5278	5972
19	N-13	27.22	MR	9.84	MS	4250	8417
20	N-14	26.19	MR	4.65	LS	3389	5611
21	BRJ-358	25.91	MR	8.98	MS	3972	6528
22	NLCW-6	21.28	MR	11.44	HS	3861	5000
23	NLCW-8	22.66	MR	9.50	MS	4417	8750
24	NLCW-12	19.79	R	10.46	HS	5000	6833
25	Mahalaxmi 296 (C)	26.00	MR	9.60	MS	4556	7306
26	CSH 16 (C)	20.00	R	7.80	MS	3361	5111
27	NTJ-1 (C)	12.09	R	8.58	MS	4056	7778
28	NTJ-2 (C)	28.89	MR	10.45	HS	4417	7500
29	NTJ-3 (C)	21.96	MR	9.52	MS	4444	9167
30	NTJ-4 (C)	30.30	MR	9.32	MS	4167	6667

Note: MR=Moderately Resistant, S=Suseptible, R=Resistant, LS=Least susceptible, HS= Highly Susceptible and MS=Moderately Susceptible

CSH 23, CSH 25, NTJ-2 (C), NTJ-3 (C), NTJ-4 (C), N-13, N-14, BRJ-358, NLCW-6 and NLCW-12 were moderately resistant with scale 5 and the genotype CSH 20MF was found to be susceptible under scale-7. The number of trichomes on adaxial leaf surface ranged from 0.00 to 177. The susceptible genotype CSH 20MF and moderately resistant genotype CSH 23 were free from trichomes. The highest number of trichomes recorded in the resistant genotypes CSV 14 R (177), followed by CSH 30 (164), CSV 29R (154), CSV 26 (153), NTJ-1 (C) (147) and CSV 22 (145) which recorded 10.13 to 14.50% dead hearts.

Based on mean stem tunnel length the genotypes were categorized as least susceptible (0-5 cm), moderately susceptible (5-10 cm), highly susceptible (>10 cm). The resistant check CSH 16 (C) found as least susceptible with 4.65 cm, whereas, NTJ-2 (C), NLCW-6 and N-14 were found to be highly susceptible as they recorded

10.45, 10.46 and 11.44 cm mean stem tunnel length respectively. The remaining genotypes found as moderately susceptible with 6.60 to 9.84 cm mean stem tunnel length.

The shoot fly resistant genotypes CSH 24MF, CSV 17, CSV 22, CSV 26, CSV 29R, CSH 30, CSH 14R, CSH 13 and NLCW-12 were showed moderate susceptibility to stem borer were onpar with the resistant check CSH 16 and NTJ-1 (C). NLCW-6 and NLCW-12 moderately resistant to shoot fly were highly susceptible to stem borer. The resistant genotype CSH 30 was non-glossy having more number of trichomes on both surfaces, medium durated, short plant height, semi-compact and symmetrical type of panicle with greyed white seed recorded higher grain and moderate fodder yields. The genotypes CSH 20MF non-glossy, free of trichomes, medium plant height and duration found to be susceptible to shoot fly and moderately susceptible to stem borer recorded significantly highest yield compared to the remaining genotypes. The genotypes CSH 13, CSV 26, CSV 216R, CSV 15, CSV 14R were high fodder yielding while the genotypes CSH 24MF, NLCW-12, N-14, CSV 17, CSV 24SS, SSV 84 were poor yielding genotypes. CSH 23, CSH 30, CSH 25, CSH 22SS were high grain yielding while the genotypes CSH 16, SSV 84, NLCW-12, CSV 14R, CSV 24SS were poor grain yielding genotypes.

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