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Reaction of different sorghum hybrids against sorghum insect pest infestation

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Abstract
An experiment was conducted at the College of Agriculture Farm, Indore, Madhya Pradesh during 2015-16 to observe the impact of two dates of sowing on 39 hybrids against the insect pests viz., sorghum shoot fly (*Atherigona soccata* Rondani), stem borer (*Chilo partellus* Swinhoe), ear head worm (*Cryptoblabes gnidiella* Mab.), ear head bug (*Calocoris angustatus* Leth.). The impact of sowing time and performance of 39 hybrid genotypes was recorded and it was found that less incidence of shoot fly (dead hearts per cent) recorded in timely sown crop (23 June, 2015) as compared to late sown crop (15 July, 2015). However, the more infestation by stem borer in all three stages (leaf injury, dead heart, stem tunnelling per cent) as well as ear head pests (bug and worm) recorded in timely sown crop as compared to late sown crop. The incidence of shoot fly on sorghum was recorded at 21 DAE and 28 DAE and the minimum shoot fly attack was recorded in both the resistant checks IS 18551 and IS 2205 in timely and late sown condition. Among the entries CSH 30, SPH 1820, CSH 16, 9 A x I 27 (LC), SPH 1814, SPH 1813, CSH 23 and CSH 25 found resistant against shoot fly in timely sown crop. While, SPH 1781, SPH 1789, SPH 1783, SPH 1811, SPH 1787 and SPH 1776 was found susceptible against shoot fly in late sown crop. Whereas, maximum shoot fly damage was observed in susceptible checks Swarna and DJ 6514 in both the stages of timely and late sown crop.
The leaf injury by stem borer under timely sowing condition was range between 2.33% to 14.00%. The minimum leaf injury per cent was observed in SPH 1776 (2.33%) whereas the maximum leaf injury was observed in DJ 6514 (14.00%). However, under late sowing condition, all the entries exhibited resistance against the pest. At 45 DAE, The lowest damage was recorded in resistant check IS 2205, IS 18551 (RC). However, maximum dead heart per cent was recorded in susceptible check Swarna (45.33%). Whereas, under late sown condition minimum dead heart per cent was recorded in SPH 1791 (3.33%) and it showed resistant reaction against stem borer with SPH 1820, SPH 1782, SPH 1819, SPH 1817, SPH 1821, SPH 1773, IS 18551 and SPH 1776. However, the maximum infestation received in susceptible check DJ 6514 (24.67%). The stem tunnelling per cent under timely sown crop condition ranged between 3.62% and 19.80% and finally all the entries exhibited resistance against the insect. Whereas, under late sown condition range of stem tunnelling was recorded between1.19% to 9.49%. Under timely sown crop condition bug and worm count ranged between 3.33 and 12.33**,** 3.00 and 15.33 respectively**.** However, under late sown condition the population of bug and worm ranged from 1.67 to 6.33 and 2.33 to 7.67.

Keywords: Sorghum, insect pests, infestation

1. Introduction
Sorghum [*Sorghum bicolor* (L.) Moench] commonly known as "Jowar", is a self-pollinated crop. It belongs to Graminae (Poaceae) and originated in North East Africa. Sorghum is an important staple food crop in the world and 5th most important cereal crop after wheat, rice, maize and barley. 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. 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 10.55, 7.1, 6.5, 5.5 and 4.6 million tons production respectively (Anonymous 2013) [2]. In India sorghum is the third important cereal after rice and wheat, grown on an average of 5.82 million ha^{-1} with production of 5.39 million tons and productivity 926 kg ha^{-1} (Anonymous 2014) [3]. In Madhya Pradesh sorghum crop is grown mainly in *kharif* season and covers an area of 253.13 thousand hectares and a production of 370.97 thousand tones with a productivity of 1500 kg ha^{-1} (Anonymous, 2014) [3]. Sorghum is cultivated in different agro ecosystems and the grain yield is influenced by various biotic and abiotic factors. Among the biotic factors, arthropods constitute a major constraint to increase the sorghum production. About 150 insect species have been reported to damage sorghum in different agro-ecosystem (Jotwani *et al.*, 1980) [13].

Among them, the shoot fly (*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. Shoot fly (*Atherigona soccata* Rondani) attacks sorghum from 5 to 30 days after seedling emergence. The stem borer (*Chilo partellus* Swinhoe) attack sorghum two weeks after seedling emergence until crop harvest and affects all plant parts except roots. The ear head bug (*Calocoris angustatus* Leth) and ear head worm (*Cryptoblabes gnidiella* Mab.) caterpillars feed mainly on the developing grains. Borad and Mittal (1983) [5] found that nearly 32.2% of the grain yield was lost due to insect damage. Nationally shoot fly has been reported to cause an average loss of 5% (Jotwani, 1983) [12]. Yield reduction of 55 to 83 % has been observed due to stem borer infestation in northern lndia (Jotwani *et al*. 1971) [11]. Losses due to panicle pests have been estimated to be over Rs. 972 million annually (Leuschner and Sharma, 1983) [17]. The major components of pest management in agro-ecosystem are cultural practices, resistant cultivars, natural enemies and pesticides. Insecticides play an important role in minimization of the insect pest population, but the farmers generally do not use plant protection measures, because of low returns. Major emphasis has been placed on developing cultivars resistant to shoot fly, stem borers, midge, shoot bug, aphid and head bugs. Considerable progress has been made in developing techniques to screen for resistance to these insects, identifying the source of resistance and transferring resistance to high-yielding sorghum cultivars (Sharma *et al*. 1992) [27]. Screening for resistance to insects under green house or field conditions is the most effective method of developing insect resistant cultivars. Cultural practices are most effective against certain insect species. The varietal selection is good agronomical tool which could be employed to minimize the damage caused by insect pests. Selection of resistant or tolerant variety is a very prominent factor for the diversity and intensity of pests in a particular area. Therefore, the present investigations are under taken to know the relative effect of sowing dates and hybrids on the incidence of different insect pests of sorghum under Madhya Pradesh condition.

2. Materials and Methods

The experiment was carried out under field conditions during the year 2015-16 at the College of Agriculture Farm, Indore (Madhya Pradesh). The medium black cotton soil (vertisol) belonging to fine montmorillonite hypothermic family of typical chromosterts predominantly clay in texture. Being less in available nitrogen and medium in available phosphorous and high potash. The normal pH varies from 7.2-7.7 slightly alkaline. The climate of this region is typically sub-tropical, semi-arid type which is characterized by extremes of weather conditions particularly during summer and winter season. The annual rainfall is reported to be 1079.9 mm per annum. The experiment plot was ploughed twice with disc plough to achieve pulverized and compact transplanting beds and levelled with heavy plank. The farm yard manure (FYM) was applied just after the first ploughing in the main field. Half of the recommended dose of nitrogen fertilizer and full dose of phosphorous and pottasic fertilizers were applied at the last ploughing and just before sowing.

Experimental details

The crop was sown during *Kharif* season on 23rd June, 2015 (timely sowing) and 15th July, 2015 (late sowing). All the genotypes were sown in two rows and all the cultural practices were followed uniformly as per the local recommendation except insecticide application. Row to row and plant to plant spacing were kept at 0.45 m and 0.12 m, respectively. The experiment was arranged in Randomized Block Design (RBD) with three replications. In this experiment 39 newly developed elite sorghum hybrid genotypes were evaluated along with three susceptible checks (DJ 6514, ICSV 745 & Swarna) and two resistant checks (IS 2205 & IS 18551) and one local check (9 A x I 27).

Shoot fly (*Atherigona soccata* Rondani)

The shoot fly incidence was recorded 21 and 28 days after emergence (DAE) of the crop plants. The total number of plants and total number of plants showing dead heart symptoms were recorded in each genotype and subjected to suitable transformations (ARC sine transformation) for onward statistical analysis. The percentage of dead heart was computed using the formula.

$$\text{Shoot fly dead hearts (\%)} = \frac{\text{No. of plants showing dead heart}}{\text{Total no. of plants inplot}} \times 100$$

Stem borer (*Chilo partellus* Swinhoe)

Three types of observations *viz*., leaf injury (%), dead heart (%), and stem tunneling (%), were recorded to characterize the damage caused by stem borer. The data were transformed and subjected to statistical analysis.

Stem borer leaf injury (SBLI) percent

Observations on leaf injury were recorded at 30 days after emergence of the crop plants. The total number of plants and total number of plants showing leaf injury symptoms were recorded in each genotype and subjected to suitable transformation for onward analysis. The percentage of leaf injury was computed using the following formula.

$$\text{Stem Borer Leaf Injury (\%)} = \frac{\text{No. of plants showing leaf injury}}{\text{Total no. of plants in plot}} \times 100$$

Stem Borer Dead heart (SBDH) Per cent

Observations on dead hearts due to stem borer attack in each genotype were also recorded at 45 days after emergence of crop. Total number of plants and total number of plants showing dead heart symptoms were recorded in each genotype and subjected to suitable transformation for onward analysis. The percentage of dead heart was computed using the following formula.

$$\text{Stem borer dead hearts (\%)} = \frac{\text{No. of plants showing dead heart}}{\text{Total no. of plants in plot}} \times 100$$

Stem borer stem tunneling (SBST)

Stem borer larvae also feed inside the stem and cause extensive tunneling. Observations were recorded at the time of harvesting on five randomly selected plants per plot. The selected plants were split open longitudinally with the help of knife and total stem length and total tunneled length was measured and then subjected to suitable transformation for onward analysis. The percentage tunneling was computed using the formula.

$$\text{Stem Borer Stem tunneling (\%)} = \frac{\text{LT}}{\text{TL}} \times 100$$

Where,
LT -Length of stem tunnel due to stem borer in cm.
TL -Total length of plant in cm.

Ear head Pests

Ear head bug (*Calocoris angustatus* Leth.) Population of ear head bug was counted on three cobs of each treatment randomly selected at milky stage of crop. Then the average number of ear head bugs per ear head was calculated and subjected to statistical analysis after making suitable transformation.

Ear head worm (*Cryptoblabes gnidiella* Mab.) Population of ear head worm was counted on three ear heads of each treatment randomly selected at milky stage of crop. Then the average numbers of ear head worm per three ear head was calculated and subjected to statistical analysis after making suitable transformation. The average population of ear head bug and ear head worm was calculated using the formula.

$$APO = \frac{NPR}{OP}$$

Where,
AP_O- Average population
NRP -No. of received pest (Ear head bug or worm)
OP-Total observed plants

Table 1: Screening criteria adopted by All India Coordinate Sorghum Improvement Project

Screening criteria	Shoot fly incidence (%)		Stem borer incidence (%)		Ear head bug population /3 plant	Ear head worm population /3 plant
	Timely sown	Late sown	Timely sown	Late sown		
Resistant	Below 20%	Below 30%	Below 20%	Below 10%	Below 5	Below 5
Moderately resistant	Below 50%	Below 60%	Below 30%	Below 30%	Below 10	Below 10
Susceptible	Above 50%	Above 60%	Above 30%	Above 30%	Above 10	Above 10

3. Results and Discussion

Shoot fly (*Atherigona soccata* Rondani) incidence

Observations on dead heart per cent were recorded to characterize shoot fly damage. The shoot fly incidence was recorded at 21 and 28 days after emergence (DAE) of the crop. The prominent symptoms of shoot fly infestation through dead heart were expressed as percentage of total plants in the plot. The significant differences were observed among all the entries tested for per cent dead hearts at 21 and 28 DAE. It was revealed from data that less number of dead hearts caused by shoot fly recorded in timely sown (23 June, 2015) crop as compared to late sown crop (15 July, 2015).

1. SFDH per cent at 21 DAE

Under timely sown crop, the lowest dead heart per cent by shoot fly was found in resistant entry IS 18551 (6.67%) which was at par with resistant check IS 2205 (9.00%). These resistant checks exhibited significant difference with all the tested entries. Among the test entries the least infestation was noted in CSH 30 (13.33%) which was at par with SPH 1820 (13.33%), CSH 16 (16.67%), 9 A x I 27 (LC) (16.67%), SPH 1814 (16.67), SPH 1813 (18.33%) and CSH 25 (18.33%) and showed resistance against the insect. The moderately resistant entries were considered as SPH 1821 (20.00%), SPH 1817 (20%), SPH 1782 (21.67%), SPH 1776 (21.67%) SPH 1812 (21.67%), SPH 1815 (21.67%), SPH 1818 (21.67%), SPH 1819 (22.00%), SPH 1785, (22.33%), SPH 1810 (23.00%), SPH 1773 (23.33%), SPH 1779 (23.33%), SPH 1791 (23.33%), SPH 1787 (24.00%), SPH 1811 (24.00%), SPH 1778 (25.00%), SPH 1783 (25.33%), SPH 1784 (26.00%), SPH 1789 (26.00%), CSH 14 (26.67%), SPH 1816 (28.33%), SPH 1780 (30.00%), SPH 1775 (31.67%), CSH 23 (32.67%), SPH 1774 (33.33%), SPH 1777 (34.33%), SPH 1781 (39.33%), ICSV 745 (SC) (43.33%) and DJ 6514 (46.67%). Whereas, the maximum shoot fly dead hearts were observed in susceptible check Swarna (53.33%) which was at par with DJ 6514 (46.67%). Similar finding were reported by Gite *et al.* (2006) [9] who evaluated 20 sorghum hybrids along with two hybrid checks (CSH 15R and CSH 19R) for shoot fly resistance and grain yield and found that hybrids AKSH 182R, AKSH 187R, AKSH 194R, AKSH 195R had more resistance to shoot fly. Kumar *et al.* (2000a) [15] evaluated 29 entries for their resistant nature to sorghum shoot fly. Among all the entries ICSV 708 and ICSV 705 were recorded the lowest dead heart, whereas CSV 1 and DJ 6514 showed highest dead heart. Kumar *et al.* (2015) [14] concluded that shoot fly was active throughout the *Kharif* season, therefore timely sowing will reduce the incidence of shoot fly. But the crop was less prone to attack of the shoot fly when the crop was sown during the early June.

Shoot fly dead heart per cent was ranged from 16.67% to 63.33% in late sown crop condition. The least dead heart per cent was noticed in resistant entry IS 18551 (16.67%) and found to be at par with resistant check IS 2205 (18.33%) and CSH 30 (26.00%). Further moderately resistant entries were observed as SPH 1785 (32.67%), SPH 1816 (32.67%), SPH 1813 (33.33%), SPH 1776 (33.33%), 9 A x I 27 (34.33%), SPH 1819 (34.33%), SPH 1819 (34.33%),SPH 1821 (35.00%), SPH 1817 (35.00%), SPH 1821 (35.00%), SPH 1817 (35.00%), CSH 23 (36.00%), SPH 1784 (36.00%), CSH 23 (36.00%), CSH 30 (36.00%), SPH 1812 (36.67%), CSH 14 (38.33%), SPH 1773 (39.00%), SPH 1782 (39.33%), SPH 1818 (39.33%), SPH 1777 (39.33%), SPH 1779 (41.00%), SPH 1780 (41.67%), CSH 25 (42.67%), SPH 1781 (42.67%), SPH 1787 (43.33%), SPH 1815 (43.33%), SPH 1814 (44.33 %), SPH 1810 (45.00%) and exhibited non-significant difference with each other followed by SPH 1774 (45.33%), SPH 1775 (45.67%), SPH 1778 (46.67%), CSH 16 (46.67%), SPH 1791 (47.33%), SPH 1820 (47.67%), SPH 1783 (48.33%), SPH 1789 (49.33%), SPH 1811 (49.33%), ICSV 745 (51.67%). However, maximum dead heart was recorded with in susceptible check DJ 6514 (63.33%) which was at par with Swarna (60.33%) and ICSV 745 (51.67%). Similar findings were reported by Vyas *et al.* (2014) [28] revealed that in IVHT grain, entries SPH 1654, SPV 462, CSV 15, SPV 2013 and SPH 1615 recorded minimum shoot fly damage. In case of local check resistance trial entries SPV 1616, PKV 809 and CSV 17 recorded minimum shoot fly.

2. SFDH per cent at 28 DAE

The dead heart per cent by shoot fly under timely sown crop condition was range between 13.33% and 56.67%. The

minimum shoot fly dead heart per cent was observed in both the resistant checks IS 2205 (13.33%) and IS 18551 (16.67%) and exhibited non- significant difference with each other. Among the moderately resistant test entries CSH 16 (22.00%) recorded less dead heart per cent as recorded at par with SPH 1776 (23.33%), 9 A x I 27 (25.00%), SPH 1785 (25.00%), SPH 1814 (25.00%), SPH 1821 (25.00%), SPH 1811 (26.67%), SPH 1817 (26.67%), CSH 30 (28.33%), SPH 1820 (28.33%), SPH 1784 (29.33%), SPH 1813 (29.33%), SPH 1818 (29.33%), SPH 1791 (30.00%), SPH 1810 (30.00%), SPH 1819 (30.00%) and followed with CSH 25 (31.67%), SPH 1779 (31.67%), SPH 1815 (32.67%), SPH 1782 (33.33%), SPH 1778 (33.33%), SPH 1812 (33.33%), SPH 1789 (35.00%), SPH 1816 (35.00%), CSH 14 (36.00%), SPH 1787 (36.00%), CSH 23 (37.33%), SPH 1773 (38.33%), SPH 1783 (39.33%), SPH 1775 (40.00%), SPH 1774 (40.00%), SPH 1777 (41.67%), SPH 1781 (42.33%), SPH 1780 (43.33%), DJ 6514 (43.33%), ICSV 745 (45.00%). whereas, maximum shoot fly incidence was recorded in susceptible check Swarna (56.67%). Similar finding was reported by Balikai and Biradar (2007) [4] evaluated twenty sorghum lines along with a resistant check (IS 2313) and a susceptible check (DJ 6514) for their resistance to shoot fly. The lines 104A, 104B, RR 9817, RR 9818, RS 585 and RS 653 were found to be resistant to the shoot fly. Shekharappa and Ramegowda (2007) [25] evaluated 11 sorghum genotypes (SPV 1155, SPV 1215, CSV 8 R, SPV 1359, SPV 1360, CSV 14 R, SPV 1380, M 35-1, Swathi, IS 2312 and DJ 6514) for resistance to *Atherigona soccata*. Among all shoot fly dead heart per cent was minimum for SPV 1360 (9.28%), followed by IS 2312 (12.1%), and maximum for the susceptible control DJ 6514 (89.80%).

However, shoot fly dead heart per cent was ranged between 29.33% and 81.87% under late sown crop. The least infestation was recorded in resistant check IS 18551 (29.33%). The resistant check IS 2205 (31.67%) showed higher incidence and categorized under moderately resistant entries and found to be at par with CSH 23 (39.33%), SPH 1784 (41.67%), SPH 1814 (43.33%), SPH 1782 (43.33%), SPH 1817 (43.33%), 9 A x I 27 (44.33%), SPH 1816 (44.33%) followed by 9 A x I 27 (46.67%), CSH 16 (46.67%), CSH 30 (48.33%), SPH 1819 (48.33%), SPH 1773 (50.67%), SPH 1813 (51.67%), CSH 25 (51.67%), SPH 1778 (53.33%), CSH 14 (53.33%), SPH 1775 (55.00%), SPH 1780 (55.00%), SPH 1810 (55.33%), SPH 1779 (56.67%), SPH 1791 (56.67%), SPH 1815 (56.67%), SPH 1812 (56.67%),SPH 1818 (58.33%), SPH 1777 (58.67%), SPH 1820 (58.67%), SPH 1821 (58.67%) and SPH 1774 (59.33%). Under the susceptible category, lower incidence was noted in SPH 1781 (60.33%), which followed with SPH 1789 (60.33%), SPH 1783 (61.67%), SPH 1811 (61.67%), SPH 1787 (63.33%), SPH 1776 (68.33%), ICSV 745 (70.67%), DJ 6514 (79.33%) and susceptible check Swarna (81.67%). (Table 3) Similar findings were also reported by Chandurwar *et al.* (1992) [6] noticed that mid late planting (August) was the most favourable time for infestation of shoot fly. Kumar *et al.* (2008b) [16] evaluated the antixenosis for oviposition, antibiosis, and recovery resistance on fifteen sorghum genotypes to *Atherigona soccata*. Antixenosis for oviposition was observed in IS 1054, IS 1057, IS 2146, IS 4664, IS 2312, IS 2205, SFCR 125, SFCR 151, ICSV 700 and IS 18551. Antibiosis was observed in IS 2146, IS 4664, IS 2312, SFRC 125, ICSV 700 and IS 18551. IS 1054, IS 1057, IS 2146, IS 2205 and IS 4664 showed lower percentages of tiller dead heart than the susceptible checks. Subbarayudu *et al.* (2011b) [26] evaluated 35 entries resistance for shoot fly and stem borer. Among all eighteen entries were resistant and fifteen entries were moderately resistant.

Table 2: Sorghum hybrid genotypes as influenced by shoot fly

S.N.	Entry	Timely Sowing		Late Sowing	
		SFDH (%) 21 DAE	SFDH (%) 28 DAE	SFDH (%) 21 DAE	SFDH (%) 28 DAE
1	SPH 1773	23.33 (28.86)	38.33 (38.19)	39.00 (38.58)	50.67 (45.39)
2	SPH 1775	31.67 (34.23)	40.00 (39.18)	45.67 (42.50)	55.00 (47.88)
3	SPH 1776	21.67 (27.60)	23.33 (28.86)	33.33 (35.25)	68.33 (55.85)
4	SPH 1777	34.33 (35.83)	41.67 (40.10)	39.33 (38.81)	58.67 (50.03)
5	SPH 1778	25.00 (29.80)	33.33 (35.22)	46.67 (43.05)	53.33 (46.92)
6	SPH 1779	23.33 (28.86)	31.67 (34.23)	41.00 (39.76)	56.67 (48.84)
7	SPH 1781	39.33 (38.81)	42.33 (40.59)	42.67 (40.73)	60.33 (50.99)
8	SPH 1787	24.00 (29.25)	36.00 (36.85)	43.33 (41.13)	63.33 (52.80)
9	SPH 1789	26.00 (30.54)	35.00 (36.24)	49.33 (44.57)	60.33 (50.99)
10	SPH 1791	23.33 (28.86)	30.00 (33.16)	47.33 (43.47)	56.67 (48.87)
11	SPH 1774	33.33 (35.17)	40.00 (39.21)	45.33 (42.26)	59.33 (50.41)
12	SPH 1780	30.00 (32.76)	43.33 (41.15)	41.67 (40.17)	55.00 (47.96)
13	SPH 1782	21.67 (27.60)	33.33 (35.22)	39.33 (38.78)	43.33 (41.13)
14	SPH 1783	25.33 (30.16)	39.33 (38.81)	48.33 (44.03)	61.67 (51.81)
15	SPH 1784	26.00 (30.54)	29.33 (32.76)	36.00 (36.85)	41.67 (40.17)
16	SPH 1785	22.33 (28.18)	25.00 (29.93)	32.67 (34.76)	44.33 (41.69)
17	SPH 1810	23.00 (28.65)	30.00 (33.16)	45.00 (42.12)	55.33 (48.11)
18	SPH 1811	24.00 (29.25)	26.67 (31.00)	49.33 (44.62)	61.67 (51.91)
19	SPH 1812	21.67 (27.71)	33.33 (35.22)	36.67 (37.26)	56.67 (48.88)
20	SPH 1813	18.33 (25.31)	29.33 (32.76)	33.33 (35.17)	51.67 (45.96)
21	SPH 1814	16.67 (24.05)	25.00 (29.93)	44.33 (41.73)	43.33 (41.11)
22	SPH 1815	21.67 (27.71)	32.67 (34.80)	43.33 (41.13)	56.67 (48.87)
23	SPH 1816	28.33 (32.14)	35.00 (36.24)	32.67 (34.76)	44.33 (41.74)
24	SPH 1817	20.00 (26.45)	26.67 (31.07)	35.00 (36.24)	43.33 (41.13)
25	SPH 1818	21.67 (27.71)	29.33 (32.76)	39.33 (38.78)	58.33 (49.89)
26	SPH 1819	22.00 (27.95)	30.00 (33.16)	34.33 (35.83)	48.33 (44.03)
27	SPH 1820	13.33 (21.34)	28.33 (32.02)	47.67 (43.65)	58.67 (50.03)

28	SPH 1821	20.00 (26.45)	25.00 (29.93)	35.00 (36.13)	58.67 (50.03)
29	CSH 14	26.67 (31.00)	36.00 (36.85)	38.33 (38.23)	53.33 (46.95)
30	CSH 16	16.67 (23.86)	22.00 (27.95)	46.67 (43.08)	46.67 (43.08)
31	CSH 23	32.67 (34.85)	37.33 (37.64)	36.00 (36.80)	39.33 (38.81)
32	CSH 25	18.33 (25.31)	31.67 (34.23)	42.67 (40.73)	51.67 (45.97)
33	CSH 30	13.33 (21.14)	28.33 (32.02)	26.00 (30.54)	48.33 (44.03)
34	9 A x I 27 (LC)	16.67 (24.05)	25.00 (29.93)	34.33 (35.83)	46.67 (43.08)
35	IS 18551 (RC)	6.67 (14.76)	16.67 (24.05)	16.67 (23.86)	29.33 (32.76)
36	IS 2205 (RC)	9.00 (17.21)	13.33 (21.14)	18.33 (24.81)	31.67 (34.02)
37	ICSV 745 (SC)	43.33 (41.15)	45.00 (42.12)	51.67 (45.97)	70.67 (57.26)
38	DJ 6514 (SC)	46.67 (43.08)	43.33 (41.15)	63.33 (52.78)	79.33 (63.03)
39	SWARNA (SC)	53.33 (46.91)	56.67 (48.85)	60.33 (50.99)	81.67 (65.00)
	S. Em. ±	1.98	1.98	2.61	2.83
	C.D. at 5%	5.59	5.57	7.36	7.98
	CV %	11.70	9.92	11.49	10.36

Values in parenthesis are transformed (arc sin transformation) value

Stem borer incidence

Three types of observations were recorded to characterize the damage caused by stem borer *viz.*, leaf injury per cent, dead heart per cent and stem tunnelling per cent. It was noticed that the more infestation in all three types of observations recorded in timely sown crop (23 June, 2015) as compared to late sowing (15 July, 2015).

1. Per cent leaf injury due to stem borer

The leaf injury by stem borer under timely sowing condition was range between 2.33% to 14.00%. The minimum leaf injury per cent was observed in SPH 1776 (2.33%) which was at par with IS 18551 (2.67%), SPH 1778 (2.67%), SPH 1820 (3.00%), SPH 1814 (3.33%), CSH 25 (3.33%), SPH 1821 (3.33%),IS 2205 (3.67%), SPH 1819 (3.67%), SPH 1791 (4.00%) and SPH 1810 (4.00%) followed by SPH 1781 (4.33%), SPH 1773 (4.33%), SPH 1787 (4.50%), SPH 1774 (4.67%), CSH 30 (5.00%), CSH 14 (5.00%), SPH 1782 (5.00%), SPH 1784 (5.00%), SPH 1813 (5.00%), SPH 1818 (5.00%), CSH 23 (5.33%), SPH 1775 (5.67%), CSH 16 (5.67%), SPH 1817 (6.00%), SPH 1777 (6.22%), SPH 1811 (6.33%), SPH 1780 (6.55%), SPH 1815 (6.67%), SPH 1783 (6.67%), SPH 1785 (7.00%), SPH 1816 (7.67%), SPH 1789 (8.33%), 9 A x I 27 (8.33%), SPH 1812 (9.67%), Swarna (10.33%), SPH 1779 (11.33%), ICSV 745 (12.00%) and DJ 6514 (14.00%). (Table 4) The above findings are in accordance with Prasad *et al.* (2011) [21] evaluated 47 sweet sorghum genotypes for resistance to stem borer and found 11 genotypes (viz., E 27, IS 18162, IS 18164, E 38, ICSV 700, ICSV 93046, NSSV 6, GGUB 50, IS 5353, KARS 95 and RSSV 9) resistant to stem borer. Jhansi (2005) evaluated eleven dual purpose sorghum genotypes for their resistance to stem borer. The genotypes showed varying levels of infestation.

However, under late sowing condition, leaf injury by Stem borer was not noticed in both resistant checks IS 18551 and IS 2205 and other 18 entries as CSH 14, CSH 16, CSH 23, SPH 1782, SPH 1773, SPH 1775, SPH 1776, SPH 1777, SPH 1791, SPH 1811, SPH 1813, SPH 1814, SPH 1815, SPH 1817, SPH 1818, SPH 1819, SPH 1820, SPH 1821. In rest of the entries the minimum leaf injury was reported in CSH 25 and SPH 1816 (2.33%) followed by SPH 1810 (3.67%), SPH 1812 (3.67%), SPH 1781 (3.78%), SPH 1789 (3.78%), SPH 1774 (4.48%), SPH 1784 (4.67%), SPH 1787 (4.82%), SPH 1780 (5.00%), SPH 1778 (5.00%), SPH 1783 (5.33%), CSH 30 (5.48%), 9 A x I 27 (5.55%), SPH 1779 (5.55%), Swarna (6.05%), ICSV 745 (6.10%), SPH 1785 (6.33%), DJ 6514 (6.89%). In this way all the entries exhibited resistance against the pest. Similar findings were reported by Parmar (2012) who revealed that the leaf injury by stem borer as 0.0% in 52 genotypes (Timely sown crop) and 60 genotypes (Late sown crop).

2. Per cent dead heart due to stem borer

The infestation at 45 DAE under timely sown condition was ranged from 11.67% to 45.33%. The lowest damage was recorded in resistant check IS 2205 (11.67%) which was at par with IS 18551 (RC) (12.83%), 9 A x I 27 (13.00%), SPH 1778 (13.33%), SPH 1817 (13.48%), SPH 1821 (13.57%), SPH 1785 (15.00%), CSH 16 (15.00%), SPH 1776 (16.67%), SPH 1818 (17.33%) and SPH 1810 (17.33%) followed by CSH 14 (17.67%), SPH 1791 (18.00%), SPH 1782 (19.00%), SPH 1814 (19.25%) and SPH 1820 (19.90%). Further the moderate resistance was noticed in test entry SPH 1781 (20.00%) with least incidence which was at par with SPH 1819 (20.17%), SPH 1813 (20.17%), SPH 1774 (20.33%), SPH 1783 (20.67%), SPH 1787 (21.67%), SPH 1816 (21.80%), SPH 1812 (23.33%), SPH 1777 (24.00%), CSH 25 (24.33%), SPH 1775 (24.67%), SPH 1780 (25.00%), SPH 1773 (25.00%), SPH 1784 (25.07%), CSH 23 (25.53%) and SPH 1789 (26.00%). However, maximum dead heart per cent was recorded with in susceptible check Swarna (45.33%) which was at par with DJ 6514 (SC) (44.50%), SPH 1815 (39.42%) and ICSV 745 (SC) (37.67%) followed by SPH 1811 (36.00%), CSH 30 (32.67), SPH 1779 (30.00%). (Table 4) Similar findings were reported by Prasad *et al.* (2011) [21] evaluated 47 sweet sorghum genotypes for resistance to stem borer and found 11 genotypes (viz., E 27, IS 18162, IS 18164, E 38, ICSV 700, ICSV 93046, NSSV 6, GGUB 50, IS 5353, KARS 95 and RSSV 9) resistant to stem borer. Vyas *et al.* (2014) [28] conducted field experiments for screening of breeder's material for stem borer. Data revealed that in IVHT grain, entries SPV 1616, SPV 1907, CSV 15, CSV 17, SPV 1870, SPV 12016, SPH 1615 and SPH 1596 recorded minimum stem borer dead hearts (2.46 and 2.92%) and minimum leaf injury by entry SPH 1648, SPV 1870 and SPH 1615,

Whereas, under late sown condition minimum dead heart per cent was recorded in SPH 1791 (3.33%) and it showed resistant reaction against stem borer, and found to be at par with SPH 1820 (3.78%), SPH 1782 (3.89%), SPH 1819 (4.90%), SPH 1817 (4.90%), SPH 1821 (5.00%), SPH 1773 (5.37%), IS 18551 (5.38%) and SPH 1776 (5.51%) followed by IS 2205 (6.24%), CSH 23 (6.44%), SPH 1781 (6.67%), SPH 1789 (6.67%), SPH 1787 (6.89%), SPH 1775 (7.04%), CSH 16 (7.16%), SPH 1783 (7.56%), SPH 1777 (7.67%),

CSH 14 (7.77%), CSH 25 (7.89%), SPH 1784 (9.00%), SPH 1818 (9.08%), SPH 1813 (9.55%), SPH 1814 (9.77%) and SPH 1811 (9.79%). Among the moderately resistant test entries SPH 1780 (10.53%) recorded less dead heart per cent and showed non-significant difference with SPH 1778 (10.55%), SPH 1812 (10.57%), SPH 1774 (10.78%), CSH 30 (11.72%), SPH 1815 (12.55%), SPH 1785 (12.67%), SPH 1779 (12.82%), SPH 1816 (13.89%) and SPH 1810 (14.00%) followed with Swarna (17.39%), 9 A x I 27 (17.67%), ICSV 745 (19.52%). However, the maximum infestation received in susceptible check DJ 6514 (24.67%). The above findings are in accordance with Divya, *et al.* (2010) [8] who found that the stem borer population was significantly higher in *kharif* than in *rabi*-summer crop.

3. Per cent stem tunnelling due to stem borer

The stem tunnelling per cent under timely sown crop condition ranged between 3.62% and 19.80%. The least dead heart per cent was noticed in resistant check IS 2205 (3.62%) and found to be at par with resistant check IS 18551 (3.74%), SPH 1773 (4.03%), SPH 1776 (4.12%), SPH 1778 (4.76%), SPH 1780 (5.27%), SPH 1791 (5.31%), SPH 1819 (5.39%) and SPH 1783 (5.78%) and followed with SPH 1777 (6.08%), SPH 1782 (6.18%), SPH 1820 (6.41%), SPH 1787 (6.44%), SPH 1813 (6.52%), SPH 1775 (6.67%), ICSV 745 (7.28%), CSH 14 (7.34%), SPH 1814 (7.36%), DJ 6514 (7.45%), SPH 1821 (8.02%), CSH 25 (8.94%), SPH 1789 (9.21%), SPH 1818 (9.38%), CSH 16 (9.51%), SPH 1781 (9.73%), SPH 1811 (10.40%), SPH 1774 (10.47%), Swarna (10.57%), CSH 23 (11.09%), SPH 1779 (11.41%), CSH 30 (12.65%), SPH 1785 (13.02%), SPH 1812 (13.43%), 9 A x I 27 (14.15%), SPH 1784, SPH 1817 (14.69%), SPH 1816 (17.99%), SPH 1810 (19.06%) and SPH 1815 (19.80%).

Whereas, under late sown condition range of stem tunnelling was recorded between1.19% to 9.49%. Among all entries SPH 1775 (1.19%) was less affected by stem borer stem tunnelling, which was at par with SPH 1782 (1.26%), SPH 1777 (1.60%), SPH 1774 (2.11%) and SPH 1817 (2.23%). Rest of the entries also exhibited resistance but performed significantly different. Similar findings were reported by Sarailoo (1986) [23] recorded 0.00% to 0.58% and 1.12% to 7.11% stem tunnelling in early and late sown crop, respectively. Gour (1995) recorded 0.51% to 12.71% stem tunnelling Ambiya (2015) [1] reported that among various entries tested for stem tunnelling, the resistant checks IS 18551 and IS 2205 were recorded as highly resistant.

Table 3: Sorghum hybrid genotypes as influenced by Stem borer attack

		Timely Sowing			Late Sowing		
S.N	**Entry**	**SBLI (%)**	**SBDH (%)**	**SBST (%)**	**SBLI (%)**	**SBDH (%)**	**SBST (%)**
1	SPH 1773	4.33 (12.00)	25.00 (29.93)	4.03 (11.38)	0.00 (0.00)	5.37 (13.35)	2.48 (9.02)
2	SPH 1775	5.67 (13.69)	24.67 (29.76)	6.67 (14.90)	0.00 (0.00)	7.04 (15.19)	1.19 (6.23)
3	SPH 1776	2.33 (8.47)	16.67 (24.05)	4.12 (11.66)	0.00 (0.00)	5.51 (13.54)	5.82 (13.95)
4	SPH 1777	6.22 (14.41)	24.00 (29.29)	6.08 (14.24)	0.00 (0.00)	7.67 (15.93)	1.60 (7.16)
5	SPH 1778	2.67 (9.36)	13.33 (21.34)	4.76 (12.54)	5.00 (12.92)	10.55 (18.89)	3.12 (10.16)
6	SPH 1779	11.33 (19.67)	30.00 (33.10)	11.41 (19.72)	5.55 (13.60)	12.82 (20.91)	5.14 (13.07)
7	SPH 1781	4.33 (11.94)	20.00 (26.45)	9.73 (18.12)	3.78 (11.14)	6.67 (14.76)	3.87 (11.26)
8	SPH 1787	4.50 (12.24)	21.67 (27.71)	6.44 (14.64)	4.82 (12.67)	6.89 (15.07)	3.48 (10.71)
9	SPH 1789	8.33 (16.74)	26.00 (30.62)	9.21 (17.65)	3.78 (11.20)	6.67 (14.76)	9.49 (17.94)
10	SPH 1791	4.00 (11.32)	18.00 (25.09)	5.31 (13.29)	0.00 (0.00)	3.33 (10.34)	4.55 (12.32)
11	SPH 1774	4.67 (12.36)	20.33 (26.64)	10.47 (18.85)	4.48 (12.21)	10.78 (19.13)	2.11 (8.18)
12	SPH 1780	6.55 (14.77)	25.00 (29.93)	5.27 (13.10)	5.00 (12.92)	10.53 (18.84)	8.38 (16.81)
13	SPH 1782	5.00 (12.92)	19.00 (25.71)	6.18 (14.35)	0.00 (0.00)	3.89 (11.32)	1.26 (6.38)
14	SPH 1783	6.67 (14.90)	20.67 (26.89)	5.78 (13.82)	5.33 (13.34)	7.56 (15.95)	5.27 (13.27)
15	SPH 1784	5.00 (12.92)	25.07 (30.03)	14.19 (22.07)	4.67 (12.46)	9.00 (17.21)	5.70 (13.80)
16	SPH 1785	7.00 (15.27)	15.00 (22.60)	13.02 (21.11)	6.33 (14.57)	12.67 (20.79)	8.05 (16.42)
17	SPH 1810	4.00 (11.48)	17.33 (24.58)	19.06 (25.86)	3.67 (10.96)	14.00 (21.95)	7.07 (15.41)
18	SPH 1811	6.33 (14.51)	36.00 (36.85)	10.40 (18.72)	0.00 (0.00)	9.79 (18.12)	5.41 (13.42)
19	SPH 1812	9.67 (18.11)	23.33 (28.86)	13.43 (21.43)	3.67 (11.02)	10.57 (18.88)	4.74 (12.48)
20	SPH 1813	5.00 (12.92)	20.17 (26.62)	6.52 (14.65)	0.00 (0.00)	9.55 (17.97)	3.36 (10.44)
21	SPH 1814	3.33 (8.61)	19.25 (25.91)	7.36 (15.66)	0.00 (0.00)	9.77 (18.17)	3.22 (10.27)
22	SPH 1815	6.67 (14.76)	39.42 (38.86)	19.80 (26.35)	0.00 (0.00)	12.55 (20.72)	4.34 (11.98)
23	SPH 1816	7.67 (15.93)	21.80 (27.71)	17.99 (25.09)	2.33 (8.74)	13.89 (21.86)	4.93 (12.81)
24	SPH 1817	6.00 (14.09)	13.48 (21.47)	14.69 (22.50)	0.00 (0.00)	4.90 (12.79)	2.23 (8.46)
25	SPH 1818	5.00 (12.92)	17.33 (24.57)	9.38 (17.83)	0.00 (0.00)	9.08 (17.49)	6.01 (14.18)
26	SPH 1819	3.67 (10.96)	20.17 (26.58)	5.39 (13.39)	0.00 (0.00)	4.90 (12.64)	5.16 (13.10)
27	SPH 1820	3.00 (9.88)	19.90 (26.40)	6.41 (14.62)	0.00 (0.00)	3.78 (10.89)	2.53 (9.10)
28	SPH 1821	3.33 (10.40)	13.57 (21.49)	8.02 (16.41)	0.00 (0.00)	5.00 (12.92)	2.48 (9.02)
29	CSH 14	5.00 (12.92)	17.67 (24.82)	7.34 (15.67)	0.00 (0.00)	7.77 (16.17)	3.56 (10.85)
30	CSH 16	5.67 (13.73)	15.00 (22.60)	9.51 (17.94)	0.00 (0.00)	7.16 (15.49)	2.41 (8.92)
31	CSH 23	5.33 (13.34)	25.53 (30.30)	11.09 (19.30)	0.00 (0.00)	6.44 (14.65)	2.64 (9.26)
32	CSH 25	3.33 (10.34)	24.33 (29.28)	8.94 (17.37)	2.33 (8.74)	7.89 (16.28)	4.34 (11.94)
33	CSH 30	5.00 (12.88)	32.67 (34.85)	12.65 (20.83)	5.48 (13.51)	11.72 (19.93)	3.69 (10.95)
34	9 A x I 27 (LC)	8.33 (16.77)	13.00 (21.04)	14.15 (22.06)	5.55 (13.60)	17.67 (24.82)	5.82 (13.91)
35	IS 18551 (RC)	2.67 (9.36)	12.83 (20.94)	3.74 (10.98)	0.00 (0.00)	5.38 (13.36)	3.85 (11.22)
36	IS 2205 (RC)	3.67 (10.86)	11.67 (19.50)	3.62 (10.82)	0.00 (0.00)	6.24 (14.34)	2.87 (9.67)
37	ICSV 745 (SC)	12.00 (20.23)	37.67 (37.82)	7.28 (15.63)	6.10 (14.26)	19.52 (26.21)	5.26 (12.96)
38	DJ 6514 (SC)	14.00 (21.95)	44.50 (41.83)	7.45 (15.75)	6.89 (15.19)	24.67 (29.74)	6.32 (14.54)
39	SWARNA (SC)	10.33 (18.67)	45.33 (42.32)	10.57 (18.95)	6.05 (14.21)	17.39 (24.61)	7.49 (15.87)

	S. Em. ±	1.16	1.85	1.08	0.41	1.19	0.81
	C.D. at 5%	3.28	5.20	3.05	1.15	3.36	2.28
	CV %	14.86	11.40	10.94	11.64	11.93	11.95

Values in parenthesis are transformed (arc sin transformation) value

4. Evaluation of hybrid genotypes for their reaction to ear head bug.

The insect count was significantly influence by different entries. The more insect population was observed in timely sown crop (23 June, 2015) as compared to late sown crop (15 July, 2015).

Under timely sown crop condition insect count ranged between 3.33 and 12.33**.** The minimum number of pest was recorded in resistance check IS 2205 (3.33) and were comparable with CSH 16 (3.67), SPH 1819 (4.00), IS 18551 (4.67) and SPH 1821 (4.67) and showed resistant against the insect. Among the moderately resistant entries ICSV 745 (5.00) recorded least infestation and found to be at par with 9 A x I 27 (5.33), CSH 14 (5.33), SPH 1791 (5.33), SPH 1820 (5.67), SPH 1774 (5.67), SPH 1783 (5.67), SPH 1789 (5.67), SPH 1784 (6.00), SPH 1817 (6.00), SPH 1780 (6.00), SPH 1815 (6.33), SPH 1781 (6.33), SPH 1777 (6.67), SPH 1785 (6.67), SPH 1787 (6.67) and SPH 1814 (6.67) followed by SPH 1773 (7.00), SPH 1782 (7.33), SPH 1778 (7.33), CSH 30 (7.67), CSH 25 (7.67), SPH 1779 (7.67), SPH 1812 (7.67), SPH 1811 (8.00), SPH 1813 (8.33), SPH 1818 (8.33), SPH 1776 (9.00), Swarna (9.00), CSH 23 (9.33), SPH 1810 (9.33) and SPH 1816 (9.67). Whereas, susceptible check DJ 6514 (12.33) recorded maximum number of bug which was at par with SPH 1775 (10.33).

However, under late sown condition the pest population range from 1.67 to 6.33. The minimum insect count was observed in both the resistant checks IS 18551 (1.67) and IS 2205 (2.00) and exhibited non-significant difference with SPH 1783 (2.33) SPH 1817 (2.33), SPH 1819 (2.33), SPH 1821 (2.33), SPH 1787 (2.67) and SPH 1779 (2.83) followed by SPH 1784 (3.00), SPH 1820 (3.00), SPH 1782 (3.00), CSH 30 (3.33), SPH 1815 (3.33), 9 A x I 27 (3.33), SPH 1780 (3.33), CSH 16 (3.33), SPH 1810 (3.33), SPH 1813 (3.33), CSH 14 (3.67), CSH 25 (3.67), SPH 1791 (3.67), SPH 1778 (4.00), SPH 1781 (4.00), SPH 1814 (4.00), SPH 1785 (4.00), SPH 1812 (4.33), SPH 1774 (4.67), CSH 23 (4.67), SPH 1811 (4.67) and SPH 1818 (4.67). Among the moderately resistant entries SPH 1777 (5.00) and SPH 1816 (5.00) received minimum number of bug and found to be at par with SPH 1773 (5.33), SPH 1776 (5.67), Swarna (5.67), SPH 1789 (5.67), ICSV 745 (6.00), DJ 6514 (6.33) and SPH 1775 (6.33). Similar finding was reported by Sekhar (1997) [24] as he studied the seasonal incidences and population fluctuation of sorghum ear head bug by planting two cultivars (CSH 1 and ICSV 1) at monthly intervals and found the pest incidence high in May-August planted crops. Choudhary and Garg (2004) [7] reported that the percentage of ear head infestation range was from 93 to 99%with the population ranged of 31.3 to 49.7 per cob. Mote and Kadam (1984) [18] evaluated 30 genotypes for damage caused by *Calocoris angustatus* and found that SPV 472, Swarna, SPH 196, CSH 1, CSH 6 and CSH 9 were moderately resistant.

5. Evaluation of hybrid genotypes for their reaction to ear head worm.

The number of head worm was significantly influenced by different entries. It was revealed that the less number of pests was recorded in late sown crop (15 July, 2015) as compared to timely sown crop (23 June, 2015).

The population of ear head worm under timely sown crop condition was range between 3.00 and 15.33**.** The minimum number of ear head bug was recorded in resistance check IS 18551 (3.00) and found to be at par with SPH 1773 (4.33), SPH 1779 (4.67) and SPH 1814 (4.67). Among the moderately resistant entries SPH 1785 (5.00), SPH 1813 (5.00) and SPH 1781 (5.00) were least infested by the ear head worm and exhibited non-significant difference with CSH 16 (5.33), SPH 1816 (5.33), SPH 1783 (5.67), SPH 1774 (5.67), IS 2205 (5.67), SPH 1778 (5.67), CSH 23 (6.33), SPH 1777 (6.33), SPH 1776 (6.33), SPH 1789 (6.67), SPH 1820 (6.67), SPH 1782 (6.67), SPH 1821 (6.67), CSH 30 (7.00), SPH 1815 (7.00) and SPH 1817 (7.00) followed by SPH 1784 (7.33), SPH 1791 (7.33), SPH 1818 (7.33), SPH 1780 (8.00), CSH 25 (8.67), SPH 1775 (8.67), CSH 14 (9.33), SPH 1810 (9.67) and Swarna (9.67). However, highest worm count was noticed in susceptible entry SPH 1812 (15.33) which was at par with SPH 1787 (12.33) and ICSV 745 (12.33) followed by SPH 1811 (11.67), DJ 6514 (11.33) and SPH 1819 (10.33) and showed susceptibility against the insect.

Further, under late sown condition the minimum worm number was recorded in resistant check IS 2205 (2.33), SPH 1783 (2.33) and SPH 1784 (2.33) and exhibited non-significant difference with CSH 16 (3.00), SPH 1782 (3.00), SPH 1773 (3.00), SPH 1810 (3.00), CSH 14 (3.33), SPH 1779 (3.33), SPH 1778 (3.33), SPH 1815 (3.33), SPH 1821 (3.33), CSH 25 (3.67), SPH 1781 (3.67), SPH 1774 (3.67), SPH 1789 (3.67), SPH 1813 (3.67) and followed with IS 18551 (4.00), SPH 1776 (4.00), SPH 1791 (4.00), 9 A x I 27 (4.33), SPH 1818 (4.33), SPH 1780 (4.33), CSH 23 (4.33), CSH 30 (4.33), SPH 1816 (4.33), SPH 1775 (4.67), SPH 1817 (4.67) and SPH 1820 (4.67).Whereas, moderately resistant entries were considered as DJ 6514 (5.00), SPH 1777 (5.33), SPH 1787 (5.33), Swarna (5.33), SPH 1811 (5.67), ICSV 745 (5.67), SPH 1814 (6.00), SPH 1819 (6.33), SPH 1812 (6.67) and SPH 1785 (7.67). The similar findings were reported by Patel (2010) [20] showed the more number of ear head worm in early sown crop as compared to late sown crop. In early sown crop the minimum ear head worm noticed in IS 2312 (0.22/plant) IS-18551 (0.66/plant), DJ-6514 (2.00/plant), SPH-1629 (2.77/ plant) and SPH-1635 (3.00/plant). The maximum ear head worm was recorded in CSH-16 (8.22/plant).While, in late sown crop minimum worm was noticed in CSH-18 (0.22/plant), SPH-1635 (0.33/plant), DJ-6514 (0.44/plant), SPH-1604 (2) (0.55/plant) and IS-2312 (0.77/plant). Raipuria (2014) reported minimum ear head worm incident in both resistance entry (IS 18551 and IS 2205), while maximum incidence was reported in all susceptible entries (DJ 6514, Swarna and ICSV 745).

Table 4: Reaction of sorghum hybrid genotypes against ear head bug and ear head worm at milky stage

		Ear head bug per 3 plant		Ear head worm per 3 plant	
SN	**Entry**	**Timely Sowing**	**Late sowing**	**Timely Sowing**	**Late sowing**
1	SPH 1773	7.00 (2.73)	5.33 (2.40)	4.33 (2.18)	3.00 (1.86)
2	SPH 1775	10.33 (3.29)	6.33 (2.60)	8.67 (3.03)	4.67 (2.26)
3	SPH 1776	9.00 (3.07)	5.67 (2.47)	6.33 (2.61)	4.00 (2.11)
4	SPH 1777	6.67 (2.66)	5.00 (2.34)	6.33 (2.60)	5.33 (2.41)
5	SPH 1778	7.33 (2.79)	4.00 (2.11)	5.67 (2.48)	3.33 (1.95)
6	SPH 1779	7.67 (2.86)	2.83 (1.82)	4.67 (2.26)	3.33 (1.93)
7	SPH 1781	6.33 (2.60)	4.00 (2.11)	5.00 (2.34)	3.67 (2.03)
8	SPH 1787	6.67 (2.67)	2.67 (1.76)	12.33 (3.58)	5.33 (2.41)
9	SPH 1789	5.67 (2.48)	5.67 (2.48)	6.67 (2.67)	3.67 (2.04)
10	SPH 1791	5.33 (2.41)	3.67 (2.04)	7.33 (2.79)	4.00 (2.11)
11	SPH 1774	5.67 (2.48)	4.67 (2.27)	5.67 (2.48)	3.67 (2.04)
12	SPH 1780	6.00 (2.55)	3.33 (1.95)	8.00 (2.88)	4.33 (2.20)
13	SPH 1782	7.33 (2.79)	3.00 (1.87)	6.67 (2.68)	3.00 (1.86)
14	SPH 1783	5.67 (2.48)	2.33 (1.66)	5.67 (2.45)	2.33 (1.66)
15	SPH 1784	6.00 (2.54)	3.00 (1.86)	7.33 (2.79)	2.33 (1.68)
16	SPH 1785	6.67 (2.67)	4.00 (2.12)	5.00 (2.33)	7.67 (2.86)
17	SPH 1810	9.33 (3.13)	3.33 (1.95)	9.67 (3.18)	3.00 (1.86)
18	SPH 1811	8.00 (2.90)	4.67 (2.27)	11.67 (3.49)	5.67 (2.47)
19	SPH 1812	7.67 (2.86)	4.33 (2.20)	15.33 (3.97)	6.67 (2.67)
20	SPH 1813	8.33 (2.97)	3.33 (1.95)	5.00 (2.33)	3.67 (2.04)
21	SPH 1814	6.67 (2.68)	4.00 (2.11)	4.67 (2.27)	6.00 (2.54)
22	SPH 1815	6.33 (2.58)	3.33 (1.93)	7.00 (2.73)	3.33 (1.95)
23	SPH 1816	9.67 (3.19)	5.00 (2.34)	5.33 (2.40)	4.33 (2.20)
24	SPH 1817	6.00 (2.54)	2.33 (1.68)	7.00 (2.73)	4.67 (2.26)
25	SPH 1818	8.33 (2.97)	4.67 (2.27)	7.33 (2.79)	4.33 (2.19)
26	SPH 1819	4.00 (2.10)	2.33 (1.68)	10.33 (3.27)	6.33 (2.61)
27	SPH 1820	5.67 (2.47)	3.00 (1.86)	6.67 (2.67)	4.67 (2.27)
28	SPH 1821	4.67 (2.27)	2.33 (1.68)	6.67 (2.68)	3.33 (1.95)
29	CSH 14	5.33 (2.41)	3.67 (2.02)	9.33 (3.13)	3.33 (1.93)
30	CSH 16	3.67 (2.04)	3.33 (1.95)	5.33 (2.40)	3.00 (1.86)
31	CSH 23	9.33 (3.13)	4.67 (2.27)	6.33 (2.60)	4.33 (2.20)
32	CSH 25	7.67 (2.85)	3.67 (2.03)	8.67 (3.03)	3.67 (2.03)
33	CSH 30	7.67 (2.84)	3.33 (1.93)	7.00 (2.73)	4.33 (2.20)
34	9 A x I 27 (LC)	5.33 (2.41)	3.33 (1.95)	10.33 (3.28)	4.33 (2.18)
35	IS 18551 (RC)	4.67 (2.27)	1.67 (1.46)	3.00 (1.86)	4.00 (2.08)
36	IS 2205 (RC)	3.33 (1.93)	2.00 (1.56)	5.67 (2.48)	2.33 (1.66)
37	ICSV 745 (SC)	5.00 (2.32)	6.00 (2.54)	12.33 (3.57)	5.67 (2.48)
38	DJ 6514 (SC)	12.33 (3.58)	6.33 (2.60)	11.33 (3.44)	5.00 (2.34)
39	SWARNA (SC)	9.00 (3.08)	5.67 (2.47)	9.67 (3.19)	5.33 (2.41)
	S. Em. ±	0.14	0.14	0.16	0.14
	C.D. at 5%	0.40	0.39	0.45	0.40
	CV %	9.26	11.47	9.90	11.40

Values in parenthesis are transformed (Square root transformation) value

4. Conclusion

1. The incidence of shoot fly on sorghum was recorded at 21 DAE and 28 DAE and it was found that the minimum shoot fly attack was recorded in both the resistant checks IS 18551 and IS 2205 in timely and late sown condition. Among the entries CSH 30, SPH 1820, CSH 16, 9 A x I 27 (LC), SPH 1814, SPH 1813, CSH 23 and CSH 25 found resistant against shoot fly in timely sown crop. While SPH 1781, SPH 1789, SPH 1783, SPH 1811, SPH 1787 and SPH 1776 was found susceptible against shoot fly in late sown crop. Whereas, maximum shoot fly damage was observed in susceptible checks Swarna and DJ 6514 in both the stages of timely and late sown crop.
2. The leaf injury by stem borer under timely sowing condition ranged between 2.33% to 14.00%. The minimum leaf injury per cent was observed in SPH 1776 (2.33%) whereas the maximum leaf injury was observed in DJ 6514 (14.00%). However, under late sowing condition, all the entries exhibited resistance against the pest. At 45 DAE, The lowest damage was recorded in resistant check IS 2205, IS 18551 (RC). However, maximum dead heart per cent was recorded in susceptible check Swarna (45.33%). Whereas, under late sown condition minimum dead heart per cent was recorded in SPH 1791 (3.33%) and it showed resistant reaction against stem borer with SPH 1820, SPH 1782, SPH 1819, SPH 1817, SPH 1821, SPH 1773, IS 18551 and SPH 1776. However, the maximum infestation received in susceptible check DJ 6514 (24.67%).
3. The stem tunnelling per cent under timely sown crop condition ranged between 3.62% and 19.80% and finally all the entries exhibited resistance against the insect. Whereas, under late sown condition range of stem tunnelling was recorded between1.19% to 9.49%.
4. Under timely sown crop condition bug and worm count ranged between 3.33 and 12.33**,** 3.00 and 15.33, respectively. However, under late sown condition the population of bug and worm ranged from 1.67 to 6.33 and 2.33 to 7.67.

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6. References

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