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Field Screening of Sorghum Genotypes for Resistance to Shoot fly, *Atherigona soccata* and Stem borer, *Chilo partellus*

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ABSTRACT
The present investigation was conducted on screening with twenty five advanced breeding lines of sorghum in randomized block design (RBD) with three replications against the shoot fly and stem borer during the Kharif season 2005-06 at Research Field, RVSKVV College of Agriculture, , Indore (M.P.), India in collaboration with AICSIP. The advanced breeding lines (genotypes) were screened on the basis of average number of eggs/10 plants, seedlings with eggs per cent/plot and dead heart per cent/plot caused by shoot fly at 14, 14 and 28 days after emergence (DAE), respectively. Observations on infestation of stem borer viz., leaf injury and dead heart per cent was recorded at 30 and 45 DAE, respectively. Under this screening programme there is one resistant (IS-2312) and one susceptible (DJ-6514) check was taken to compare with other genotypes. Results on shoot fly revealed that the highly susceptible genotypes was reported to SPH-1577 (3.69/10 plants), CSV-18 (56.83%) and CSV-14 (78.82%) in terms of number of eggs, seedlings with egg and dead heart, respectively whereas genotypes i.e. SPH-1568, SPH-1568, and SPH-1564 were found to be significantly minimum number of eggs (2.88/10 plant), seedlings with egg (30.22%) and dead heart (43.85%), respectively. Further, the genotypes i.e. SPH-1567 (61.60%) followed by SPH-1564 (58.70%) and SPH-1569 (58.70%) were found highest leaf injury whereas, SPH-1567 (14.34%) followed by SPH-1561 (13.40%) and SPH-1568 (11.06%) were recorded maximum dead heart and considered as highly susceptible genotypes to stem borer. Genotypes viz., SPH-1578 (14.80%) followed by SPH-1566 (21.40%) was recorded as significantly least leaf injury, while in both genotypes viz., SPH-1564 and SPH-1571, there is no infestation of dead heat was recorded and these lines were found to be significantly highly resistant against the stem borer.
Key words: *Sorghum, screening, genotypes, Atherigona soccata, Chilo partellus*

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INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] locally known as Jowar is the fifth most important cereal crop in the world after wheat, rice, maize and barley. In India it has positioned third after rice and wheat. Sorghum grown in low and moderate rainfall condition and it has general ability to withstand drought makes it an ideal crop for rainfed condition. Importance of sorghum is increasing day by day because of its multiple uses as flour for bread and porridge as poultry feed, Jaggery syrup glucose, alcohol industrial raw material green and dry fodder for cattle. In India, during the year 2015-16 sorghum was cultivated in 5.65 million ha area with production of 4.41 million tonnes and productivity of 780 kg/ha [1]. In Madhya Pradesh it was grown as a rainfed crop and was cultivated in about 0.21 million ha area with an annual production of 0.41million tones and productivity of 2000 kg/ha [1]. It has been experienced since last few decades the average production of sorghum has slightly declined. The biotic and abiotic factors are the major constraints which attributes its lower production. Among the biotic factors about 150 insect pests have been reported in different agro ecosystem of sorghum crop [25, 26]. Out of them sorghum shoot fly, *Atherigona soccata* Rondani (Diptera: Muscidae) and stem borer, *Chilo partellus* Swinhoe (Lepidoptera: Pyralidae) are the major insect pests which severely devastate to sorghum crop. Shoot fly is the most destructive one and causes severe damage in the early seedling stage at 7-30 days after seedling emergence. Shoot fly lays white elongated cigar shaped eggs on the lower surface of the leaf, after hatching the maggot crawls to the plant whorl and moves downward between the fold of young leaves till they reach the growing point causes the central whorl leaf to die, resulting in characteristic "dead-heart" symptoms [5, 8]. The serious attacks of shoot fly on sorghum crop reduce the plant population and cause yield losses with a tune of 80–90% of grain, and 68% of fodder yield in India [2, 18, 13]. On the other hand stem borer is also play an important role in reduction of sorghum production. The infestation of *C. partullus* is about 4-45% in sorghum and maximum infestation occurred during August, which declined gradually in September and October [28].

To combat the attacks of insect pests there are many agro-chemicals are injudiciously applied as their control measures alone which render the insect resistance, pest outbreaks, pollution in agro-ecosystem. Under these circumstances to avoid pesticide risks in environment the development of resistance cultivars are the best resort. Host plant resistance is the most important approach for controlling shoot fly and stem borer damage. Resistance to shoot fly and stem borer in sorghum is expressed in terms of antixenosis for ovipositon, antibiosis and tolerance [23-26, 9, 21].Thus, present studies on different genotypes of sorghum were planned to screening against their major insect pests to enhance the production in a way to sustainable and practical manners.

MATERIALS AND METHODS

The trial was conducted on field screening of sorghum genotypes for resistance against the shoot fly and stem borer during *Kharif* season, 2005-06 at Research Field, College of Agriculture, RVSKVV, Indore (M.P.), India in collaboration with All India Coordinated Sorghum Improvement Project (AICSIP) center, Indore. The trial was laid out in randomized block design with three replications having plot size 4m × 0.45m with spacing between rows and plants 0.45m and 0.10m, respectively. In the presentation investigation, one resistant (IS-2312) and one susceptible (DJ-6514) check was taken for screening with other genotypes. Observations on number of eggs per plant laid by shoot fly were recorded at 14 days after emergence (DAE) and damage of per cent dead heart on 28 DAE. Total number of plants and total number of dead hearts were counted from each plot replication wise. Observations on damage of stem borer mainly leaf injury per cent and dead heart per cent was recorded at 30 DAE and 45 DAE, respectively. The injured plants showed characterized pinhole symptoms on leaves. To counts the dead heart infestation caused by shoot fly and stem borer the total number of plants and total number of dead hearts were counted from each plot replication wise which was later calculated in dead heart per cent (%) with a formula as given below:

$$\text{Dead heart caused by shoot fly (\%)} = \frac{\text{Number of plant showing dead heart}}{\text{Total number of plants in the plot}} \times 100$$

$$\text{Dead heart caused by stem borer (\%)} = \frac{\text{Number of plant showing dead heart}}{\text{Total number of plants in the plot}} \times 100$$

The data on shoot fly eggs were calculated by transformed value $\sqrt{x+0.5}$ while per cent seedlings with eggs and symptoms of dead heart caused by both shoot fly and stem borer were computed by angular transformation (Arc-sign) and statistically analyzed following the method of analysis of variance as suggested by Fisher and Yates [12].

RESULTS AND DISCUSSION

Screening against sorghum shoot fly, *Atherigona soccata*:

The results on overall number of eggs, seedlings with egg per cent and dead heart per cent caused by shoot fly are presented in Table1. It is depicted from the table there was significant different between the genotypes in respect of number of eggs laid per plant of shoot fly in last July. It was observed that the average number of eggs/10 plants at 14 DAE was ranged from 2.88 to 3.69. The minimum number of eggs per plant was recorded on genotypes SPH-1568 (2.88). However, entries *viz.,* SPH-1573(2.93), CSV-17(2.93), SPH-1571(3.05), SPH-1562 (3.07), SPH-1561(3.09), SPH-1569(3.16), SPH-1567(3.21), SPH-1565(3.25), SPH-1342(3.25), SPH-1564(3.26), SPH-1572(3.31), SPH-1576(3.31), SPH-1570(3.36), CSV-17(3.36) SPH-1563(3.39) SPH-1575(3.40), SPH-1574(3.41), CSH-18(3.41), SPH-1578(3.41), CSH-17(3.45) were exhibited lower oviposition as compared to that of susceptible check DJ-6514 with 3.50 eggs/plant with shoot fly eggs at 14^{th} DAE. Whereas, the maximum number eggs per plant were recorded in SPH-1577(3.69) flowed by SPH-1566(3.64) which was higher than susceptible check. It is revealed that the significant difference exhibited in respect of ovipositional preferences by shoot fly in field under natural infestation conditions. Further, seedlings with eggs per cent of shoot fly was ranged from 30.22 to 56.83% at 14th DAE. The genotypes viz., SPH-1568 (30.22) followed by SPH-1578(30.50), SPH-1570(31.69), SPH-1342(32.72), SPH-1574(33.11), SPH-1569(33.20) SPH-1571(33.38), SPH-1565(33.46), SPH-1561(33.87), SPH-1564(34.19), CSH-17(35.93), SPH-1576(36.05), SPH-1575(36.28), SPH-1577(36.49), SPH-1573(36.64), CSV-17(36.99), SPH-1572(37.46), SPH-1567(38.40), SPH-1563(39.00), CSV-14(39.15) and SPH-1566(39.17) were showed lower seedlings with egg per cent as compared to that of susceptible check DJ-6514(40.51). The genotypes *viz.,* SPH-1568, SPH-1578, SPH-1570, SPH-1342, SPH-1574, SPH-1569, SPH-1571, SPH-1565, SPH-1561, SPH-1564, CSH-17, SPH-1576, SPH-1575, and SPH-1577 were found to be lower than resistant check IS-2312 with 37.08% of seedlings with eggs of shoot fly. Whereas, the maximum seedlings with eggs percent was recorded in CSH-18 (56.83%) followed by SPH-1566(39.17%), SPH-1563(39.00%) which was higher than that of resistant check which considered as highly susceptible genotype to shoot fly. The lowest dead heart per cent caused shoot fly was ranged from 43.85 to 78.82% at 28 DAE which was significantly differed among the genotypes. The superior entries viz., SPH-1564(43.85), SPH-1574(48.47), SP-1571(53.48), SPH-1563(53.83), SPH-1568(55.44), CSH-18(57.61), SPH-1572(58.09), SPH-1566(59.11), SPH-1569(59.41), SPH-1561(59.60), CSH-17(59.66), SPH-1565(60.02), SPH-1565(60.08), SPH-1578(60.80), SPH-1576(62.05), SPH-1577(63.72), SPH-1573(64.22) and SPH-1575(66.51) were noticed lower dead heat per cent as compared to that of susceptible checks DJ-6514(66.77). Other remaining genotypes viz., CSV-17(67.18), SPH-1562(69.10), SPH-1342(71.52) and CSV-14 (78.82) were exhibited significantly higher dead heart per cent over the susceptible which was found be highly susceptible genotypes. Similar results were also reported by Balikai and Kullaisamy [4]; Kandalkar *et al.* [10]; Dhillon *et al*. [14].

Screening against sorghum stem borer, *Chillo partellus*:

The perusal of data on leaf injury and dead heart per cent caused by stem borer is evident that the leaf injury per cent at 30 DAE was exhibited significantly different among 25 genotypes which was varied from 14.80 to 61.60%. The genotypes *viz.,* SPH-1568 (14.80), SPH-1566(21.40), CSV-17(23.60), SPH-1573(23.90), SPH-1562(26.30), CSH-14(27.50), SPH-1561(30.30), SPH-1563(30.50), SPH-1572(33.70) and SPH-1574(34.10) were expressed minimum as compared to that of susceptible check DJ-6514 with 36.30% of leaf injury caused by stem borer. Other genotypes *viz.,* SPH-1570(37.10), CSH-17(37.60), CSH-18(37.68), SPH-1575(40.40), SPH-1565(40.70), SPH-1342(43.40), SPH-1568(48.70), SPH-1577(50.20), SPH-1571(52.20), SPH-1576.(58.00) SPH-1564(58.70), SPH-1569(58.70) and SPH-1567(61.60) were recorded higher leaf injury per cent as compared to susceptible check one. Results revealed that the breeding lines *viz.,* SPH-1568 (14.80), SPH-1566(21.40), CSV-17(23.60), SPH-1573(23.90), SPH-1562(26.30), CSH-14(27.50), SPH-1563(30.50) were exhibited lowest leaf injury per cent as compared to resistant check IS-2312(33.00%) which could be consider as best genotypes against the stem borer.

The data presented in Table 2 revealed significant difference in respect of dead heart per cent of sorghum stem borer which was ranged from 0.00 to 14.34% at 45 days after emergence. The minimum number dead heart per cent was recorded on genotypes are SPH-1564(0.00), SPH-1571(0.00), SPH-1574(1.38), CSH-18(1.66) and SPH-1569(2.36) which was lower than resistant check IS-2312 with 3.40% dead heart and these genotypes might be considered as resistant lines. While other genotypes *viz.,* SPH-1565(4.13), SPH-1572(4.72), CSH-14(4.72), SPH-1573(4.84), SPH-1578(5.04), SPH-1575(6.13), SPH-1342(6.48), CSH-17(6.64), SPH-1566(6.66), SPH-1570(7.14), SPH-1563(7.66) were SPH-1576(7.87) were exhibited lower as cpmpared to that of susceptible check DJ-6514 with 8.00% with dead heart. Genotypes *viz.,* SPH-1562(8.00), DJ-6514(8.00), CSV-17(8.03), SPH-1568(11.06), SPH-1561(13.40) and SPH-1567 (14.34) were found to be highly susceptible to stem borer. The present finding broadly corroborated with the studies of Trehan and Butani [29] who observed higher infestation of *C. partellus* during kharif (July to August sown crop than in September-October sown crop). Similar result were also reported by Firke and Kadam [11], Panwar and Sarup [19] on maize. Similarly, Singh *et al*. [27]) Marulasiddesha [15] also reported that the highest incidence (27%) of *C. partellus* was recorded in month of October on sweet sorghum.

This varied reaction of different genotypes was mainly associated with egg laying indicating ovipositional non-preference as a primary mechanism of shoot fly and stem borer resistance. The similar observations were recorded by various workers [6, 7, 8, 14, 16-21, 3, 23, 24].

Table1. Number of eggs/10 plant, seedling with eggs (%) and dead heart (%) caused by sorghum shoot fly in different genotypes.

S. No.	Genotypes	14th DAE	14th DAE	28 DAE
		No. of eggs/10plant	Seedling with egg%	Dead heart %
1	SPH-1561	3.09 (1.89)#	33.87 (35.59)*	59.60 (50.53)*
2	SPH-1562	3.07 (1.89)	33.05 (35.09)	69.10 (56.23)
3	SPH-1563	3.39 (1.97)	39.00 (38.65)	53.83 (47.22)
4	SPH-1564	3.26 (1.94)	34.19 (35.78)	43.85 (41.18)
5	SPH-1565	3.25 (1.94)	33.46 (35.34)	60.02 (50.91)
6	SPH-1566	3.64 (2.03)	39.17 (38.75)	59.11 (50.74)
7	SPH-1567	3.21 (1.93)	38.40 (38.29)	60.95 (51.64)
8	SPH-1568	2.88 (1.84)	30.22 (33.35)	55.44 (48.06)
9	SPH-1569	3.16 (1.91)	33.20 (35.18)	59.41 (50.53)
10	SPH-1570	3.36 (1.96)	31.69 (34.26)	60.08 (50.87)
11	SPH-1571	3.05 (1.88)	33.38 (35.29)	53.48 (47.12)
12	SPH-1572	3.31 (1.95)	37.46 (37.74)	58.09 (50.65)
13	SPH-1573	2.93 (1.85)	36.64 (37.25)	64.22 (53.33)
14	SPH-1574	3.41 (1.98)	33.11 (35.13)	48.47 (44.10)
15	SPH-1575	3.40 (1.97	36.28 (37.04)	66.51 (54.65)
16	SPH-1576	3.31 (1.95)	36.05 (36.90)	62.05 (56.67)
17	SPH-1577	3.69 (2.05)	36.49 (37.16)	63.72 (52.96)
18	CSV-17	2.93 (1.85)	36.99 (37.46)	67.18 (56.45)
19	CSV-14	3.36 (1.96)	39.15 (38.73)	78.82 (63.47)
20	SPH-1342	3.25 (1.94)	32.72 (34.89)	71.52 (57.90)
21	CSH-17	3.45 (1.99)	35.93 (36.83)	59.66 (50.80)
22	CSH-18	3.41 (1.98)	56.83 (48.93)	57.61 (49.62)
23	SPH-1578	3.41 (1.98)	30.50 (33.52)	60.80 (51.36)
24	IS-2312	2.50 (1.73)	37.08 (37.51)	18.48 (25.25)
25	DJ-6514	3.50 (2.00)	40.51 (39.53)	66.77 (55.87)
SEm ±		**0.185**	**2.597**	**4.90**
CD at 5%		**0.374**	**5.248**	**13.60**
		NS	**S**	**S**

= Figure in parentheses are transformed value √ x+0.5, *= Figures in parenthesis are angular transformed value (Arc sign), DAE= days after emergence, NS = Non significant, S= Significant

CONCLUSIONS

The present investigation revealed that the genotypes taken in breeding line program well attributing traits with resistance ability against the shoot fly and stem borer for achieving high yielding varieties of sorghum. The mean numbers of egg laid by soot fly per plant were lowest (2.88%) and highest (3.69%) on genotypes SPH-1568 and SPH-1577, respectively. The genotypes SPH-1568 and SPH 1578 were found superior over rest of the genotypes with lowest seedlings with egg per cent. The genotypes CSH-18 was promising having highest (56.83%) number of eggs in young seedling stage. Genotypes SPH-1564 and SPH-1574 were least per cent of dead heart while, in genotype CSV-14 was recorded highest dead heart per cent caused by shoot fly which was higher than resistant check IS-2312. Least per cent of leaf injury caused by stem borer was found to SPH-1578 and SPH-1566 while higher leaf injury was recorded in genotype SPH-1567 at 30 DAE. Whereas, minimum dead heart per cent was recorded in genotype SPH-1564 and SPH-1571 while, maximum dead heart was recorded in SPH-1567 followed by SPH-1561. It was observed that infestation of shoot fly and stem borer was moderate to high in the Kharif season 2005-06. Both genotypes viz., SPH-1564 and SPH-1571 were found highly resistant against shoot fly and stem borer.

Table 2. Leaf injury (%) and dead heart (%) caused by sorghum stem borer in different genotypes.

S. No.	Genotypes	30 DAE	45 DAE
		Leaf injury %	Dead heart %
1	SPH-1561	30.30 (35.90)	13.40 (21.36)
2	SPH-1562	26.30 (30.59)	8.00 (16.12)
3	SPH-1563	30.50 (33.25)	7.66 (16.06)
4	SPH-1564	58.70 (49.64)	0.00 (0.00)
5	SPH-1565	40.70 (35.69)	4.13 (11.61)
6	SPH-1566	21.40 (27.25)	6.66 (14.85)
7	SPH-1567	61.60 (35.02)	14.34 (22.15)
8	SPH-1568	48.70 (44.23)	11.06 (19.27)
9	SPH-1569	58.70 (49.64)	2.36 (8.75)
10	SPH-1570	37.10 (37.17)	7.14 (15.30)
11	SPH-1571	52.20 (47.81)	0.00 (0.00)
12	SPH-1572	33.70 (34.91)	4.72 (12.50)
13	SPH-1573	23.90 (27.95)	4.84 (12.69)
14	SPH-1574	34.10 (35.54)	1.38 (5.29)
15	SPH-1575	40.40 (39.34)	6.13 (14.23)
16	SPH-1576	58.00 (51.05)	7.87 (16.26)
17	SPH-1577	50.20 (45.54)	5.04 (12.76)
18	CSV-17	23.36 (28.03)	8.03 (16.23)
19	CSV-14	27.50 (31.31)	4.72 (12.50)
20	SPH-1342	43.40 (41.11)	6.48 (14.45)
21	CSH-17	37.60 (37.74)	6.64 (14.72)
22	CSH-18	37.68 (37.51)	1.66 (7.33)
23	SPH-1578	14.80 (22.46)	4.84 (13,27)
24	IS-2312	33.00 (34.41)	3.40 (10.44)
25	DJ-6514	36.30 (36.81)	8.00 (16.43)
SEm ±		**5.65**	**1.32**
CD at 5%		**15.66**	**3.78**
		S	**S**

Figures in parenthesis are angular transformed value, DAE= days after emergence,
S= Significant

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