International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 1869-1873

Received: 24-01-2019
Accepted: 28-02-2019

Sitaram Karoriya
Department of Entomology, College of Agriculture, Gwalior, Madhya Pradesh, India

AS Yadav
Scientist Senior Scale (Entomology) R.V.S. Krishi Vishwa Vidyalaya- Krishi Vigyan Kendra, Morena, Madhya Pradesh, India

Hariom Singh Yadav
R.V.S. Krishi Vishwa Vidyalaya- Zonal Agricultural Research Station, Morena, Madhya Pradesh, India

VK Shrivastava
Professor & Head Department of Entomology, College of Agriculture, Gwalior, Madhya Pradesh, India

Correspondence
Sitaram Karoriya
Department of Entomology, College of Agriculture, Gwalior, Madhya Pradesh, India

Host plant resistance of sorghum genotypes against shoot fly (*Atherigona soccata* Rondani) and stem borer (*Chilo partellus* Swinhoe) in Madhya Pradesh-India

Sitaram Karoriya, AS Yadav, Hariom Singh Yadav and VK Shrivastava

Abstract
Field trials were carried out during Kharif 2014-15 to evaluate host plant resistance for shoot fly and stem borer in 14 genotypes of sorghum. Based upon hierarchical clustering considering parameters of stem borer per cent plant infestation, dead heart caused by stem borer, stem tunneling, peduncle tunneling, number of larvae/plant and number of tunnel per plant genotypes CSH-22SS, IS-22186, CSH-24MF, CSX-24SS and ICSSH-28 were found less susceptible to stem borer and genotype SSG-59 and N-610 was found highly susceptible to stem borer. And also genotypes IS-22670, ICSSH-28 was found less susceptible to shoot fly.

Keywords: Sorghum, shoot fly, stem borer, host plant resistance

Introduction
Sorghum [*Sorghum bicolor* (L.) Moench] locally known as Jowar has high yielding potential comparable to those of rice, wheat and maize. Sorghum is well known for drought tolerance and water use efficiency of sorghum is more than other cereals. Hence, sorghum is most suitable cereal crop for rainfed farming. Sorghum is one of the main staple food for the world's poorest and most food insecure people across the semi-arid tropics. India contributes about 16% of the world's sorghum production. After evolving, many hybrids and varieties the average productivity is still low because the grain yield are influenced by various biotic and abiotic factors. Among the biotic factors, arthropods constitute major constraints to increase of sorghum production. The attack of many insect pests causes severe losses to the sorghum. Over 150 insect species have been reported to damage sorghum in different agro-ecosystems (Jotwani *et al.*, 1980) [4]. Out of them shoot fly (*Atherigona soccata* Rondani) and stem borer (*Chilo partellus* Swinhoe) causes enormous losses to the sorghum crop every year. Shoot fly (*Atherigona soccata* Rondani) attacks sorghum from 5 to 30 days after seedling emergence. The stem borer Chilo partellus attack in sorghum starts from two weeks old seedlings, affects all plant parts except the roots and persists up to crop harvest. The neonate larvae scrap the leaf chlorophyll, and the early instar larvae while feeding in the whorl cause irregular shaped pinholes which later convert to elongated lesions on the leaves. The older larvae leave the whorl, bore into the stem where it cuts the growing point resulting in "dead heart" symptom. In older plants, the larva feeds inside the stem causing extensive tunneling. Feeding and stem tunneling by C. partellus larvae cause huge crop losses due to interference with translocation of metabolites and nutrients, thus resulting in poor development of grains, stem breakage, lodging, direct damage to panicles and loss in grain yield. Several control strategies such as crop rotation, field sanitation, introduction of parasitoids, early planting, seed treatment and use of insecticides have been employed for the control of these pest but their deployment have not given satisfactory control. In such a scenario, host plant resistance could be exploited as one of the most effective mean of minimizing losses due to insect pests and sustainable sorghum production. Host plant resistance is the most important component of integrated pest management. It dose not involve any extra cost or require application skills in pest control techniques. It is compatible with other methods of pest management. Host plant resistance can also enhance the effectiveness of natural enemies and reduce the need to use pesticides. This help to preserve the environment and avoid the risk associated with the use of pesticide.

Material and Methods

The experiment was carried out during *kharif* season, 2014-15 at the Research Farm, College of Agriculture, RVSKVV-Gwalior (M.P.). The material was planted in a randomized block design with three replications in 11th July 2014 and screening was done under natural infestation. The crop was sown in rows to row 45cm and plant to plant 12cm distance. Plot consisted of parallel four rows 4 m long. One week after seedling emergence, thinning was carried out to maintain spacing of 12 cm between the plants. All the agronomy practices were followed to raise the crop successfully with recommended dose of fertilizers (80 kg N2: 40 kg P2O5: 40 kg K2O / ha). The following 14 Sorghum genotypes were sown in this investigation.

1. ICSSH-28
2. CMSX-5630
3. Sel-B-POP
4. CSH-22SS
5. ICSY-93046
6. IS-27206
7. CSH-24MF
8. CHOHATIA
9. CSX-24SS
10. SSV-74
11. Grid-39
12. IS-22670
13. IS25186
14. Gird-8

Method of observation

Following observation was recorded to evaluate the advanced sorghum resistant genotypes against *Chilo partellus* Swinhoe. During growth period two types of observations viz., leaf injured plants and dead heart formation were recorded at 30 and 45 days after emergence to work out the per cent plant infestation and per cent dead heart caused by stem borer. The plants were randomly selected to record the stem tunneling, peduncle tunneling, number of larvae/pupae present in stem and peduncle at harvesting time. Number of holes in stem and peduncle were also recorded in selected plants. On the basis of observed data, per cent stem tunneling and per cent peduncle tunneling were calculated. The data obtained from a set of observations for each character were tabulated and analyzed by the method of "Analysis of variance" as suggested by Fisher and Yates (1938).

Results and Discussion

Reaction of genotypes against shoot fly *Atherigona soccata*

Dead heart caused by shoot fly

Observations recorded on per cent dead heart caused by shoot fly at 14 days after emergence showed significant difference among different varieties (Table 1). Minimum dead heart (12.7%) was recorded in genotype IS-22670, which found significantly less than the dead heart in genotypes ICSSH-28, IS-27206, Sel-B-POP and CSH-22SS but was at par with rest of the genotypes. Maximum dead heart (17.1%) was recorded in genotype SSV-74 which found significantly higher than the genotypes Grid-39 CSH-24MF, ICSY-93046 and CHOHATIA but was at par with rest of the genotypes. Data recorded at 28 days after emergence minimum dead heart (14.2%) was recorded in genotype ICSSH-28, which found significantly less than the genotypes IS-22670, IS-25186, IS-27206, CSH-22SS, Sel-B-POP Grid-8 and CSH-24MF but was at par with rest of the genotypes whereas maximum dead heart (18.3%) was recorded in genotype Grid-39 which found significantly higher than the dead heart in SSV-74, CSH-24MF and CHOHATIA but was at par with rest of the genotypes. Similar results was also found by Gour 1995 [3] who reported 5.93 to 50.29 percent head heart caused by shoot fly various genotypes tested. Khandare *et al;* (2013) [5] reported host plant resistance against shoot fly in different genotypes.

Table 1: Reaction of sorghum genotypes against shoot fly

S. No.	Genotypes	Per cent dead heart at	
		14 DAE	28 DAE
1	ICSSH-28	13.1 (21.19)*	14.2 (22.08)*
2	CMSX-5630	15.3 (22.99)	16.6 (24.05)
3	Sel-B-POP	13.5 (21.39)	15.5 (23.10)
4	CSH-22SS	13.8 (21.80)	15.4 (23.08)
5	ICSY-93046	16.0 (23.46)	16.9 (24.26)
6	IS-27206	13.4 (21.28)	14.9 (22.56)
7	CSH-24MF	16.1 (23.51)	17.9 (24.93)
8	CHOHATIA	16.0 (23.47)	17.7 (24.81)
9	CSX-24SS	14.4 (22.26)	15.6 (23.25)
10	SSV-74	17.1 (24.31)	18.3 (25.29)
11	Grid-39	17.0 (24.30)	18.4 (25.36)
12	IS-22670	12.7 (20.83)	14.8 (22.57)
13	IS25186	14.0 (21.98)	14.8 (22.58)
14	Gird-8	14.1 (22.03)	15.8 (23.40)
	SE(m)± CD at 5%	(0.63) (1.83)	(0.63) (1.85)

DAE – Days after emergence
* Figures in parenthesis are arc sign values

Reaction of genotypes against stem borer *Chilo partellus*

Per cent plant infested

Data recorded on per cent plant infested by stem borer at 30 days after emergence showed significant difference among different genotypes (Table 2). Significantly less plant infestation (9.1%) was recorded in genotype CSH-22SS than rest of the genotypes except IS- 25186, CSH-24MF, SSV-74, Gird-8, *IS-22670,* and ICSSH-28. Whereas, significantly higher plant infestation (21.9%) was recorded in genotype IS25186 than all the tested genotypes except ICSY-93046,

Table 2: Reaction of sorghum genotypes against infestation of stem borer (*Chilo partellus* Swinhoe)

S. No	Genotype	Plant Infestation (%)		Dead Heart (%)		Stem tunneling (%)*	Peduncle tunneling (%)*
		30 DAE*	45 DAE*	30 DAE*	45 DAE**		
1	ICSSH-28	11.2 (19.47)*	56.0 (48.45)*	1.77 (7.23)*	9.20 (18.45)*	16.2(23.75)*	15.1 (22.82)*
2	CMSX-5630	14.0 (21.83)	51.9 (46.05)	2.07 (7.99)	9.00 (17.45)	12.6 (20.77)	11.1 (19.30)
3	Sel-B-POP	12.9 (20.85)	54.5 (45.87)	2.03 (8.06)	8.83 (17.24)	15.2 (22.89)	12.9 (20.700
4	CSH-22SS	9.1 (17.21)	51.0 (45.58)	1.80 (7.31)	9.27 (17.69)	16.3 (23.76)	22.5 (28.27)
5	ICSY-93046	19.0 (25.71)	59.1 (50.24)	3.13 (10.10)	10.13 (18.55)	26.5 (30.95)	25.7 (30.43)
6	IS-27206	14.4 (21.96)	53.3 (46.90)	3.03 (9.73)	9.23 (17.62)	10.0 (18.44)	13.3 (21.33)
7	CSH-24MF	10.6 (18.53)	54.5 (47.59)	1.97 (7.78)	9.03 (17.48)	14.8 (22.61)	27.5 (31.49)
8	CHOHATIA	14.3 (22.11)	53.2 (46.80)	2.43 (8.91)	8.97 (17.41)	18.7 (25.54)	16.1 (23.34)
9	CSX-24SS	10.9 (18.72)	59.2 (50.26)	1.93 (7.76)	10.33 (18.74)	14.2 (22.15)	21.5 (27.55)
10	SSV-74	12.5 (20.61)	56.0 (48.45)	2.07 (8.23)	10.02 (18.45)	5.19 (13.15)	11.5 (19.78)
11	Grid-39	11.4 (19.39)	58.0 (49.61)	1.67 (7.04)	10.23 (18.60)	19.4 (26.09)	30.2 (33.23)
12	IS-22670	10.0 (18.38)	50.8 (45.42)	1.57 (7.19)	8.53 (16.97)	18.7 (25.60)	20.5 (26.85)
13	IS25186	21.9 (27.72)	58.5 (49.86)	3.67 (10.90)	9.93 (18.36)	17.9 (24.99)	6.3 (14.37)
14	Gird-8	10.9 (18.92)	49.6 (44.75)	2.27 (8.44)	8.80 (17.17)	20.5 (26.88)	13.4 (20.34)
	SE(m)±	(1.24)	(2.18)	(0.64)	(0.97)	(1.39)	(2.43)
	CD at 5%	(3.62)	(N.S.)	(1.88)	(N.S.)	(4.06)	(7.10)

* Figures in parenthesis are arc sign values

** Figures in parenthesis are $\sqrt{n+0.5}$ values

Per cent dead heart caused by *Chilo partellus*

Observations recorded on per cent dead heart caused by stem borer at 30 days after emergence indicated that significant difference among different genotypes (Table 2). Minimum dead heart (1.57%) was recorded in genotype IS-22670, which found significantly less than the genotypes IS25186, ICSY-93046 and IS-27206 but was at par to rest of the genotypes. On the other hand maximum dead heart (3.67%) was recorded in genotype IS25186, which found significantly higher than rest of the genotypes except genotypes ICSY-93046 and IS-27206.

Stem tunneling by stem borer

Data recorded at harvest on stem tunneling caused by stem borer showed significant differences in different genotypes (Table 2). Minimum stem tunneling (5.19%) was recorded in genotype SSV-74, which found significantly less than the tunneling in rest of the genotypes. Whereas, maximum and significantly higher stem tunneling (26.5%) was recorded in ICSY- 93046 than all the tested genotypes except Gird-8.

Peduncle tunneling by stem borer

The peduncle tunneling caused by stem borer was found significantly less in genotype IS-25186 than rest of the genotypes except CMSX-5630, SSV-74, ICSSH-28, IS-27206, IS-25186, Gird-8 and Sel-B-POP. Whereas, higher peduncle tunneling (30.2%) was recorded in genotype Grid-39 than rest of the genotypes except CSH-24MF, ICSY-93046 CHOHATIA and CSH22SS (Table 2).

Number of larvae of stem borer

Data recorded on number of larvae per stem showed no significant difference among different genotypes (Table 4). Minimum number of larvae (1.60/5stem) was recorded in genotype IS-27206 whereas, maximum number of larvae (3.40/5stem) were recorded in ICSSH-

28. But observations recorded on number of larvae/5peduncle showed significant differences among the genotypes. Minimum larval population (0.40/5peduncle) was recorded in genotypes IS27206, which found significantly less than the population recorded in IS-22670, Grid-39, and CSH24MF, but was at par to rest of the genotypes. Maximum larval population (1.27/5peduncle) was recorded in CSH-24MF, and Grid-39, which have significantly higher than rest of tested genotypes except IS-22670.

Number of tunnels caused by stem borer

Observations recorded on number of tunnel/5stem showed significant difference among different genotypes (Table 3). Minimum number of tunnel (1.93/5stem) were recorded in genotype ICSSH-28, which found significantly less than rest of the genotypes except IS27206, CSX-24SS,SSV-74,IS-22670, and IS-25186, Whereas, maximum number of tunnels (5.60/5stem) were recorded in ICSY-93046, which found significantly higher than rest of the genotypes.

Number of holes caused by stem borer

Observations recorded on number of holes caused by stem borer in stem and peduncle showed significant differences among different genotypes (Table 4). Significantly less number of holes (4.0/stem) were recorded in genotype SSV-74 than rest of the genotypes except IS- 27206.Whereas, higher number of holes (13.6) were recorded in genotype Grid-39 than rest of the genotypes except ICSY-93046 and ICSSH-28.

Significant differences were recorded in per cent plant infested by stem borer among different genotypes at 30 days after emergence. The per cent plant infestation in different genotypes at 30 days after emergence ranged from 9.1 to 21.9. Minimum plant infestation in CSH-22SS showed their resistance to stem borer followed by IS-22186, CSH-24MF, CSX- 24SS and ICSSH-28. Whereas, maximum infestation in IS25186 showed their higher susceptibility followed by CSY-93046, CHOHATIA and CMSX-5630. The per cent dead heart formed by stem borer was also significantly differ among different genotypes at 30 days after emergence. At 30 days after emergence per cent dead heart caused by stem borer ranged from 1.57 to 3.67%. Minimum dead heart in IS-22670 showed their resistance to stem borer followed by Grid-39 ICSSH-28 and CSH-22SS. whereas, maximum dead heart in IS25186 indicates their higher susceptibility to stem borer followed by ICSY- 93046, IS-27206 and CHOHATIA. Singh and Shankar (2000) carried out a field experiment and reported that with regard to the incidence of the stem borer (*Chilo partellus*) and shoot fly (*Antherigona soccata*), MASV 33/93, ICSV 700 and PB 15438 were found to be consistently superior.

Stem tunneling and peduncle tunneling by stem borer in different genotypes were also differ significantly. Stem tunneling in different genotypes ranged from 5.19 to 26.5%. Minimum stem tunneling in genotype SSV-74 showed their less susceptibility to stem borer followed by IS27206 and CMSX-5630. Whereas, maximum tunneling in ICSY-93046 indicates their higher susceptibility to stem borer. Peduncle tunneling among different genotypes ranged from 6.3 to 30.2%. Minimum peduncle tunneling in genotype IS-25186 showed their less susceptibility to stem borer. Whereas, maximum tunneling in Grid-39 showed their higher susceptibility. Bhadviya (1995) [1] reported 2.0 to 35.58% stem tunneling and 5.2 to 35.0% peduncle tunneling in different varieties of sorghum. Gour (1995) [3] also reported 0.51 to 12.71% stem tunneling and 5.46 to 57.6% peduncle tunneling among different varieties. The stem and peduncle tunneling might be associated with the presence of silica content and stem hardening in the genotypes. Number of larvae recorded in stem and peduncle of different genotypes ranged from 2.0 to 4.67 with significant differences among them. Minimum and similar number of larvae recorded in genotypes IS-27206 indicates their less susceptibility followed by SSV-74, CSX- 24SS and CSH-22SS. Less number of larvae recorded on these genotypes indicate the presence of antibiosis in these genotypes. Whereas, maximum number of larvae in Grid-39 indicates their higher susceptibility to stem borer. Number of tunnel recorded in different genotypes ranged from 2.86 to 7.1 with significant differences among them. Minimum number of tunnel recorded in ICSSH-28 indicate that this genotype might be less preferred for feeding by stem borer. During present investigation genotype IS-27206 was found to be less susceptible on the basis of dead heart, stem and peduncle tunneling. Chaturvedi (2000) [2] also reported genotype CSV 74 to be less susceptible against stem borer on the basis of plant infestation, larval population and stem and peduncle tunneling caused by stem borer. Whereas, Prem Kishore (2005) [6] reported CSV 15 to be higher susceptible. This variation in the susceptibility might be due to genotypes taken by different workers. Number of holes recorded in different genotypes ranged from 5.50 to 16.50 with significant differences among them. Minimum number of holes recorded in SSV-74 indicate their less susceptibility to stem borer followed by IS-27206, IS-25186 andCSX-24SS. On the other hand genotype Grid-39 showed their higher susceptibility to the pest followed by ICSY- 93046 ICSSH-28 and CHOHATIA. Subbarayudu *et al*; (2011) recorded multiple resistance in sorghum genotypes against *Atherigona soccata* and *Chilo partellus.* Sunita Yadav and S. P. Singh (2014) [8] also found resistance in sorghum genotypes against *Atherigona soccata* and *Chilo partellus*.

Table 3: Effectiveness of different genotypes of sorghum on stem borer (*Chilo partellus* Swinhoe) infestation

S. No.	Genotypes	Number of larvae / 5 stem	Number of larvae /5 peduncle	Number of tunnel / 5stem	Number of tunnel / 5peduncle
1	ICSSH-28	3.40 (2.10) *	0.93 (1.39) *	1.93 (1.71)*	0.93 (1.39)*
2	CMSX-5630	3.27 (2.07)	0.87 (1.36)	3.87 (2.21)	0.80 (1.34)
3	Sel-B-POP	2.60 (1.90)	0.47 (1.21)	3.27 (2.06)	0.80 (1.340
4	CSH-22SS	2.13 (1.76)	0.83 (1.34)	3.13 (2.03)	1.33 (1.53)
5	ICSY-93046	3.33 (2.08)	0.73 (1.30)	5.60 (2.57)	1.50 (1.57)
6	IS-27206	1.60 (1.61)	0.40 (1.18)	2.20 (1.79)	0.90 (1.38)
7	CSH-24MF	3.00 (2.00)	1.27 (1.51)	3.67 (2.16)	1.80 (1.67)
8	CHOHATIA	2.93 (1.98)	0.60 (1.26)	3.73 (2.18)	0.73 (1.32)
9	CSX-24SS	2.20 (1.79)	0.53 (1.24)	2.53 (1.88)	0.73 (1.31)
10	SSV-74	1.67 (1.63)	1.00 (1.41)	3.60 (2.14)	0.80 (1.34)
11	Grid-39	3.40 (2.10)	1.27 (1.50)	3.93 (2.22)	1.27 (1.50)
12	IS-22670	2.87 (1.96)	1.13 (1.46)	3.53 (2.13)	1.27 (1.50)
13	IS25186	2.40 (1.84)	0.87 (1.35)	3.20 (2.05)	1.00 (1.40)
14	Gird-8	2.47 (1.86)	0.87 (1.36)	3.67 (2.16)	0.87 (1.36)
	SE(m)±	(0.14)	(0.91)	(0.15)	(0.12)
	CD at 5%	(N.S.)	(0.26)	(0.43)	(N.S.)

* Figures in parenthesis are arc sign values

Table4: Effectiveness of different genotypes of sorghum on stem borer (*Chilo partellus* Swinhoe) infestation

S. No.	Genotypes	Number of hole/ 5stem	Number of hole/ 5peduncle	Total
1	ICSSH-28	11.3 (3.50)*	2.0 (1.72)*	13.30 (2.62)
2	CMSX-5630	9.8 (3.26)	2.4 (1.84)	12.20 (2.56)
3	Sel-B-POP	8.2 (3.02)	1.5 (1.57)	9.70 (2.31)
4	CSH-22SS	7.4 (2.90)	3.4 (2.10)	10.80 (2.50)
5	ICSY-93046	12.5 (3.68)	3.1 (2.01)	15.60 (2.85)
6	IS-27206	5.1 (2.46)	2.0 (1.71)	7.10 (2.10)
7	CSH-24MF	9.9 (3.29)	3.2 (2.04)	13.10 (2.67)
8	CHOHATIA	10.0 (3.31)	1.4 (1.55)	11.40 (2.43)
9	CSX-24SS	6.5 (2.73)	1.9 (1.680	8.40 (2.22)
10	SSV-74	4.0 (2.23)	1.5 (1.59)	5.50 (1.91)
11	Grid-39	13.6 (3.82)	2.9 (1.98)	16.50 (2.90)
12	IS-22670	7.9 (2.97)	2.2 (1.78)	10.10 (2.39)
13	IS25186	7.3 (2.87)	0.9 (1.36)	8.20 (2.13)
14	Gird-8	9.3 (3.19)	2.1 (1.74)	11.40 (2.48)
	SE (m)±	(0.17)	(0.08)	(0.19)
	CD at 5%	(0.49)	(0.43)	(0.56)

* Figures in parenthesis are arc sign value

References

1. Bhadviya DK Evaluation of different sorghum genotypes for their reaction to the pest complex. M.Sc. (Ag.) Thesis, JNKVV, Jabalpur (M.P.), 1995.
2. Chaturvedi H. Studies on insect pest complex of sorghum and varietal reaction against stem borer (*Chilo partellus* Swinhoe). M.Sc. (Ag.) Thesis, JNKVV, Jabalpur (M.P.), 2000.
3. Gour DS. Studies on insect pests of sweet sorghum with reference to their seasonal incidence. M.Sc. (Ag.) Thesis, JNKVV, Jabalpur (M.P.), 1995.
4. Jotwani MG, Young WR, Tests GL. Elements of integrated control of sorghum pest. FAO Pl. Prod. and Prot. Paper, FAO, Rome, 1980, 159.
5. Khandare RP, Patil SP, Burghate SK, Kalpana Kurhade. Screening of advanced breeding material of sorghum against shoot fly (*Atherigona soccata*) (Rondani) Journal of Agricultural Science. 2013; 3(8):305-307.
6. Premkishore. Resistance to shoot fly, *Antherigona soccata* Rondani and stem borer, *Chilo partellus* (Swinhoe) in new germ plasm of sorghum. J Ent. Res. 2005; 25(4):273- 282.
7. Subbarayudu B, Prasad GS, Kalaisekar A, Bhagwat VR, Aruna C. Evaluation of multiple resistance in sorghum genotypes against shoot fly, *Atherigona soccata* (Rondani) and stem borer *Chilo partellus* (Swinhoe). Indian Journal of Entomology. 2011; 73(1):26-29.
8. Yadav Sunita, Singh SP. Multiple resistances in forage sorghum genotypes to the spotted stem borer, *Chilo partellus* (Swinhoe) and sorghum shoot fly, *Atherigona soccata* (Rondani). Annals of Biology. 2014; 30(1):127-130.