Indian J. Appl. Ent. **32**(1) : 42–47 (2018)

SCREENING OF DIFFERENT SORGHUM VARIETIES FOR RESISTANCE AGAINST SORGHUM SHOOT FLY

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ABSTRACT

A field experiment was conducted to evaluate the resistance of different sorghum varieties against sorghum shoot fly (*Atherigona soccata* Rondani) during *Kharif*, 2017 at the Agronomy farm, Rajasthan College of Agriculture, Udaipur. Among all varieties, CSV-23 was observed better than the all other varieties with a minimum mean per cent oviposition (53.35) at 12 DAG. The variety CSV-23 was also observed to be significantly superior over all the other varieties on the 14th, 21st and 28th day after germination with a mean dead heart of 11.22, 16.77 and 20.82 per cent, respectively was is at par with variety CSV 20 in the terms of oviposition and mean dead heart per cent.

Keywords: *Atherigona soccata* Rondani, sorghum, oviposition, dead heart, varieties.

INTRODUCTION

Sorghum [*Sorghum bicolour* (L.) Monch], commonly known as jowar is one of the important crops of dry land agriculture in semi arid tropics. It is an important food and fodder crop providing not only food for millions of people in developing countries, but also provides a bulk of fodder to farm animals and is a prime source of income in dry land area. The major sorghum growing states in our country are Maharashtra, Karnataka, Rajasthan, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Gujarat. In Rajasthan, it is extensively cultivated in Ajmer, Tonk, Pali, Udaipur, Rajsamand, Chittorgrah, Bhilwara and Jaipur districts on 5.79 lakh hectare area with an annual production of about 3.49 tonnes, yield of 603 kg per ha and productivity of 763 kg per ha.

The major insect pests that infest sorghum are shoot fly (*Atherigona soccata* Rondani), grasshopper (*Hieroglyphus banian* Fabricius), grey weevil (*Myllocerus undecimpustulatus* Marshall), stem borer (*Chilo partellus* Swinhoe), aphid (*Aphis sacchari* Zehntner) and termite (*Odontotermes obesus* Rambur). Among these biotic stresses sorghum shoot fly, *Atherigona soccata* is a serious pest that reduces sorghum production in the semi-arid tropics. The shoot flies attack sorghum between 7 to 28 days after the germination (Nwanze *et al*., 1990) causing dead hearts formation and at times lead to the complete failure of crop under severe infestation. Due to shoot fly infestation, grain loss of 80–90% and 68% of fodder yield has been recorded in India (Balikai and Bhagwat, 2009 and Kahate *et al*., 2014). The shoot fly (*Atherigona soccata*) in particular infest the sorghum crop in early phase of vegetation and can be effectively managed by adoption of proper seed treatment technology.

MATERIAL AND METHODS

A field experiment to screen different sorghum varieties for resistance against sorghum shoot fly" was carried out at Agronomy farm during *Kharif* 2017. The field experiment was conducted under natural infestation condition. Varieties *viz.,* SPV-245, CSV- 20, CSV- 10, CSV- 23, PJ- 1430, PC- 1080, RC- 1 and RC- 2 were sown on 5th July in a randomized block design with three replications. Each replication consisted of eight plots of 1.5x4.0 square meter plot size with row to row and plant to plant spacing of 50 cm x 15 cm. There were three rows of plants for each treatment in each plot.

The observations on the resistance to shoot fly infestation were recorded in each plot in terms per cent dead heart formation, oviposition, plant height, leaf glossiness, plant vigour, and grain yield. The crop was inspected regularly for the infestation by other pests and was protected after one month of crop growth by adopting a standard protection measures.

Observation:

Regular field visits were made to observe the number of eggs and dead heart formation caused by *A. soccata* on plants during morning hours. The observations were recorded at 12 day after germination for oviposition, while at 14, 21, 28 days after germination for dead heart formation during early hours of the day (6:30-8:30 a.m.) and for yield at the time of harvesting.

(i) Leaf glossiness:

The observations on leaf glossiness were recorded on 10 randomly selected tagged plants at 12 days after germination for each variety in each replication by grading on 1 to 5 scale rating. The plants with low leaf glossiness were scaled 1-2, with medium leaf glossiness as 3 and the scale of 4-5 indicate the very high leaf glossiness.

(ii) Plant vigour:

The observation on plant vigour on 10 randomly selected plants was recorded at 12 days after germination for each variety in each replication by visual grading the plants on 1 to 5 scale rating. The plants with low plant vigour were scaled 1-2, with medium plant vigour as 3 and the scale of 4-5 indicate the very high plant vigour.

(iii) Oviposition:

The oviposition by shoot fly was recorded on 10 randomly selected plants for each variety in each replication. The oviposition by *A. soccata* was recorded by counting the number of plants with shoot fly eggs at 12 days after germination. The per cent plants with shoot fly oviposition were calculated for each variety as mentioned below.

$$\text{Oviposition (\%)} = \frac{\text{Number of plants with eggs}}{\text{Total number of plants observed}} \times 100$$

(iv) Dead hearts:

The number of plants showing dead hearts formation due to shoot fly infestation were recorded at 14, 21 and 28 days after germination in each variety in each replication and the data were expressed as a per cent of dead hearts.

$$\text{Dead heart (\%)} = \frac{\text{Number of plant with dead heart}}{\text{Total number of plants observed}} \times 100$$

(v) Plant height:

Ten randomly selected plants of each variety were tagged and height of plant from its base to central leaf area was recorded at harvest.

(vi) Grain yield:

After harvesting the grain yield of each variety in each replication was recorded after threshing and drying of grains and grain yield per hectare was calculated. The data on resistance attributing parameters were statistically analysed for variance and the varieties were finally categorised as resistant/less susceptible, moderate resistant/susceptible and highly susceptible.

$$\text{Yield (q/ha)} = \frac{\text{Yield per plot (kg)}}{\text{Area of plot (sq. mtr)}} \times 100$$

Statistical analysis for correlation:

The per cent dead heart formation was correlated with the yield attributing characters viz., plant vigour, leaf glossiness and simple correlation was calculated by the Karl Pearson formula:

$$r_{xy} = \frac{\sum XY - \frac{(\sum X)(\sum Y)}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

Where,

r_{xy} = Simple correlation coefficient.

X = Variable component i.e. average plant vigour and leaf glossiness

Y = Variable i.e. mean dead heart percent per plant.

n = Number of paired observations.

To find out the significance of correlation following formula is used:

$$t = \frac{r}{\sqrt{1 - r^2}} \times \sqrt{n - 2} \sim t_{n-1} \text{ d. f.}$$

The calculated t-value obtained was compared with tabulated t-value at 5% level of significance.

RESULTS AND DISCUSSION

The screening of varieties is important to identify a source of resistance among different varieties. It has been in practice since long to evaluate the varieties/genotypes for resistance and to identify the varieties/ genotypes which withstand adverse climate conditions, pests, disease. In the present investigation eight commonly growing sorghum varieties were screened against sorghum shoot fly, *A. soccata* Rondani under late sown conditions and observation were recorded on following parameters:

1. Leaf glossiness
2. Plant vigour
3. Oviposition
4. Dead heart formation
5. Grain yield

Resistance of plants to insects is generally derived from morphological and biochemical characters of a plant, which affect the behavior and biology of the insects and influence the relative degree of damage caused by insects. Therefore the resistant attributing factors were studied and evaluated in order to identify the resistant, moderately by resistant and susceptible variety under present investigation. The role of HPR in pest management has been described earlier by various workers (Jotwani, *et al.* 1971 and Sharma, 1993).

Leaf glossiness:

The results of the present investigation presented in Table (1) reveal that the maximum leaf glossiness in terms of 1-5 rating was recorded in variety CSV-23 (4.67) followed by variety CSV-20 (4.33) at 12 days after germination and were considered resistant varieties against shoot fly. The varieties PC-1080 (3.67), SPV-245 (3.67), RC-1(3.33), RC-2 (3.33) and PJ-1430 with a mean rating of 3.00 were next in order and considered as moderately resistant varieties against shoot fly in terms of leaf glossiness during *Kharif* 2017. The minimum leaf glossiness rating of 1.67 was recorded in variety CSV-10 and was considered to exhibit susceptibility/least resistant against shoot fly during *Kharif* 2017. The result of present investigation gets full support from the findings of Joshi *et al*. (2011), Satish *et al.* (2009) and Patil *et al*. (2006) who found that higher leaf glossiness play a great role in imparting resistance against shoot fly infesting sorghum plants. Sonalkar *et al.* (2013) also found that Shoot fly damage was positively correlated with seedling glossiness score.

Plant vigour:

The result of the present investigation presented in Table (1) reveal that the maximum mean plant vigour on the basis of 1-5 rating was recorded in the promising resistant variety CSV-23(4.67) and CSV-20(4.67) at 12 days after germination followed by varieties PC-1080(4.00) and RC-1(4.00) during *Kharif* 2017. The varieties SPV-245, RC-2 and CSV-10 exhibited vigour rating of 3.33 and were statistically at par with each other and were considered as moderately susceptible/ resistant against shoot fly in the terms of mean plant vigour rating. The minimum mean plant vigour rating was recorded in variety PJ-1430 (2.0) and was categorised as susceptible against shoot fly. The finding of the present investigation is in close conformity with findings of Prasad *et al.* (2015) who recorded that higher plant vigour in sorghum was responsible for imparting multiple resistance to *A. soccata*. Similarly Sharma and Nwanze (1997) have also found plant vigour as an important morphological character imparting resistance against shoot fly infesting sorghum.

The correlation between plant vigour and leaf glossiness with per cent dead heart formation presented in Table (2), reveal that the plant vigour (-0.83) and leaf glossiness (-0.93) index were significantly negatively correlated with dead heart formation.

Table 1. Screening of different varieties against sorghum shoot fly, *Atherigona soccata* Rondani during *Kharif* 2017

S. No.	Varieties	Leaf Glossiness (1-5)	Plant Vigour (1-5)	Egg (%) 12 DAG	Dead Heart (%) 14 DAG	Dead Heart (%) 21 DAG	Dead Heart (%) 28 DAG	Plant Height (cm.)	Yield (q/ha)
V1	SPV- 245	3.67	3.33	54.78 (66.74)	22.94 (15.19)	27.12 (20.78)	30.17 (25.26)	199.33	27.20
V2	RC- 2	3.33	3.33	53.07 (63.90)	23.63 (16.07)	27.28 (21.01)	30.22 (25.33)	310.67	23.48
V3	RC-1	3.33	4.00	54.99 (67.09)	23.15 (15.45)	27.13 (20.80)	30.78 (26.18)	361.33	23.58
V4	CSV-20	4.33	4.67	48.85 (56.69)	20.06 (11.76)	24.21 (16.82)	27.16 (20.83)	264.33	32.55
V5	PJ-1430	3.00	2.00	66.14 (83.64)	26.37 (19.73)	31.09 (26.67)	36.40 (35.21)	185.33	24.32
V6	PC-1080	3.67	4.00	57.00 (70.33)	23.05 (15.33)	27.09 (20.73)	30.83 (26.27)	296.67	28.44
V7	CSV-10	1.67	3.33	66.14 (83.64)	26.59 (20.04)	31.11 (26.69)	36.73 (35.77)	266.67	24.23
V8	CSV-23	4.67	4.67	46.92 (53.35)	19.57 (11.22)	24.17 (16.77)	27.15 (20.82)	252.33	33.11
S.Em±		0.10	0.07	3.77	1.08	1.41	1.71	2.47	0.10
C.D. (5%)		0.31	0.22	11.42	3.29	4.27	5.20	7.50	0.31

Figures in parentheses are retransformed per cent values;

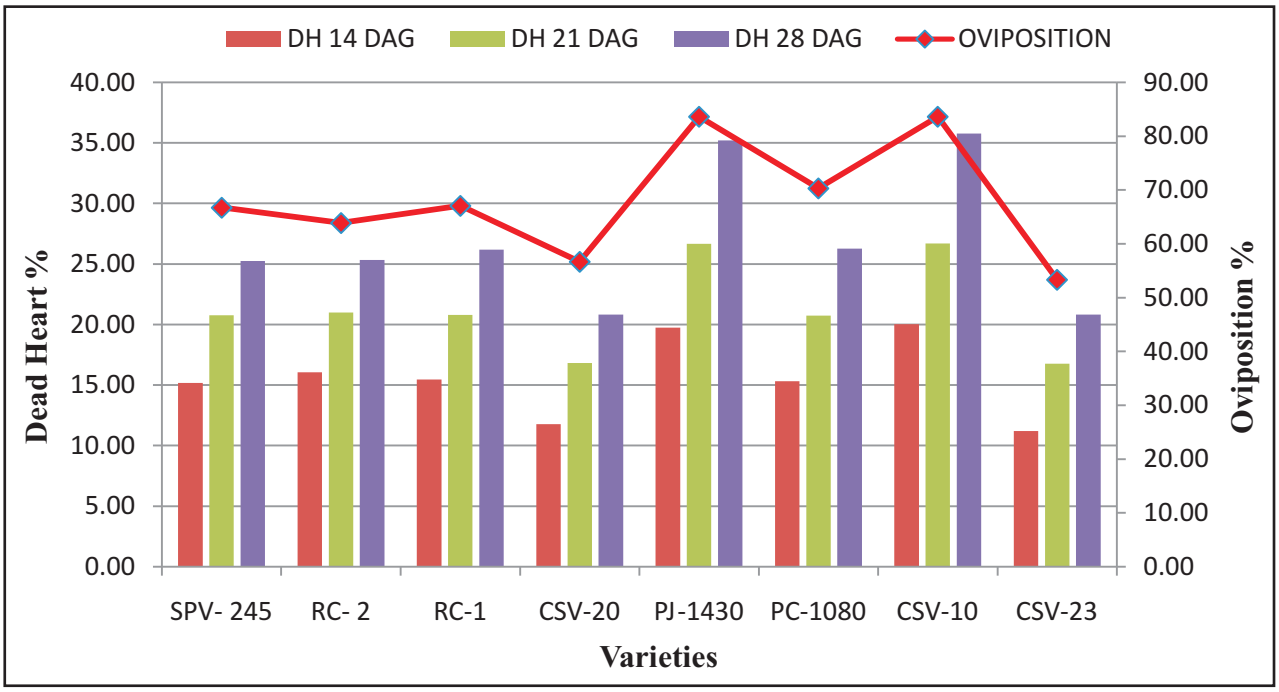

Fig.1: Oviposition and dead heart formations by shoot fly, *A. soccata* on different sorghum varieties

It is apparent from the results of present investigation that variety CSV-23 and CSV-20 recorded higher plant vigour and leaf glossiness rating exhibiting resistance against shoot fly during *Kharif* 2017. The results can be explained on the basis that varieties with high plant vigour and leaf glossiness are less prone to *A. soccata* attack because of their olfactory or gustatory responses to the insects. Further the plant vigour may hamper the ability of larvae to reach the growing point thereby preventing dead heart formation. These findings are in close conformity with the findings of Joshi *et al*., (2011), Prasad *et al.,* (2015) and Pawar *et al.,* (2015) who studied the effect of plant physical characters on the incidence of shoot fly and established a negative correlation with them.

Oviposition:

The results of the present investigation tabulated in Table (1) and depicted in Fig (1) reveal that during *Kharif* 2017 the lowest per cent mean number of plant with shoot fly egg at 12 day after germination were recorded in the variety CSV-23 with 53.35 per cent mean plants having shoot fly oviposition. It was followed by variety CSV-20 (56.69 per cent). The results indicated these two varieties were at par with each other with lower shoot fly oviposition and were catagorised as promising varieties against *A. soccata*. On the other hand varieties CSV-10 and PJ-1430 with mean 83.64 per cent plants with shoot fly eggs recorded maximum

Table 2. Correlation of plant vigour and leaf glossiness with mean dead heart per cent in sorghum during *Kharif* 2017

Varieties	Plant Vigour	Leaf glossiness	Mean dead heart formation (%)
SPV- 245	3.33	3.67	61.34
RC- 2	3.33	3.33	62.47
RC-1	4.00	3.33	62.58
CSV-20	4.67	4.33	49.64
PJ-1430	3.00	3.00	81.67
PC-1080	4.00	3.67	62.38
CSV-10	3.33	2.67	82.54
CSV-23	4.67	4.67	48.93
Mean	3.79	3.58	63.94
Correlation between mean dead heart per cent and plant vigour		-0.83*	
Correlation between mean dead heart per cent and leaf glossiness		-0.93*	

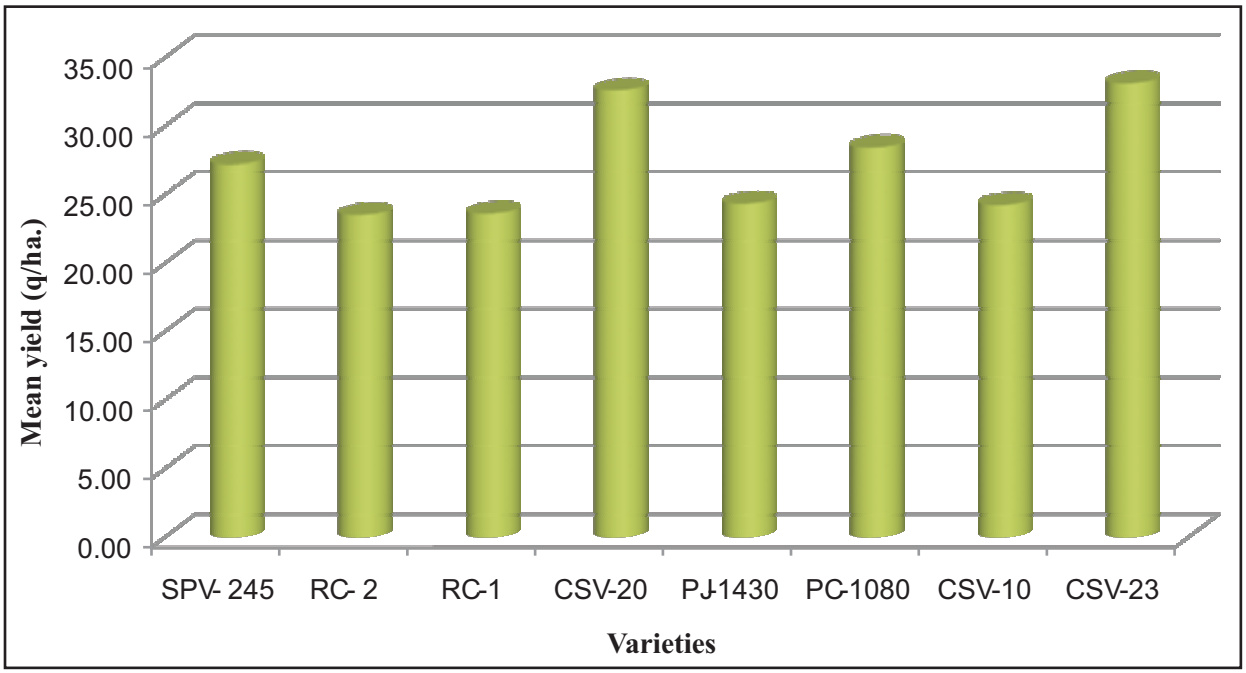

Fig.2: Mean grain yield of sorghum (q/ha.) in different varieties

oviposition and were catagorised as highly susceptible varieties to shoot fly and were also at par with each other. The varieties RC-2 (63.90%), SPV-245 (66.74%), RC-1 (67.09%) and PC-1080 (70.73%) were intermediate in order of oviposition by shoot fly and were categorised as moderately resistant against shoot fly in terms of oviposition by shoot fly. Earlier workers (Kumar *et al*., 2003 and Bhatt, 2003) have established that oviposition of shoot fly have a great role in deciding varietal resistance/susceptibility to shoot fly. The present findings are in agreement with the findings of Shrawan *et al.* (2009), who found variety CSV-23 as resistant in terms of oviposition by shoot fly followed by genotypes SU 1343 and SU 1341.

Dead heart formation at 14, 21 and 28 days after germination:

The result of the present investigation presented in Table (1) depicted in Fig (1) on the per cent dead heart formation in eight varieties of sorghum during *Kharif* 2017 revealed that lowest per cent dead hearts formation was recorded in variety CSV-23 with 11.22, 16.77 and 20.82 per cent mean plants showing dead heart formation at 14, 21 and 28 days after germination respectively during *Kharif* 2017. It was followed by varieties CSV-20 (11.76, 16.82 and 20.83), SPV-245 (15.19, 20.78 and 25.26), PC-1080 (15.33, 20.73 and 26.27), RC-1 (15.45, 20.80 and 26.18), RC-2 (16.07, 21.01 and 25.33), PJ-1430 (19.73, 26.67 and 35.21) and CSV-10 (20.04, 26.69 and 35.77) in order of per cent mean plant showing dead heart formation at 14, 21 and 28 days after germination respectively, during *Kharif* 2017. The variety CSV-10 recorded highest mean dead heart formation by shoot fly and the remaining varieties were found to have moderate infestation in terms of dead heart formation. It is apparent from the data recorded on mean dead heart formation that the variety CSV-23 with minimum per cent of mean plants with dead heart formation can be categorised as resistant variety whereas variety CSV-10 with maximum per cent of mean plants with dead heart formation as least resistant or susceptible variety. The result of the present investigations are in accordance with findings of Hussain, (2014), Khandare *et al*., (2013) and Vyas *et al.*, (2014), who have indicated that a higher shoot fly dead heart formation has been exhibited by susceptible varieties, whereas the dead heart formation in resistant varieties was relatively lower.

Grain yield:

The data recorded on grain yield (Table 1 and Fig 2) at harvest reveal that among all the varieties the highest mean grain yield was recorded from variety CSV-23 (33.11 q/ha) followed by variety CSV-20 (32.55 q/ha). All the varieties performed significantly superior over variety RC-2 (23.48 q/ha) which was statistically at par with variety RC-1 (23.58 q/ha). The findings of the present investigation are in alignment with the results of various workers (Patel and Sukhani, 1990, Yadav, 2000

and *Swathi et al.,* 2016) who recorded a higher grain yield in resistant cultivars as compared to susceptible cultivars.

ACKNOWLEDGEMENTS

The authors are grateful to the Dean, RCA and Head, Department of Entomology, RCA, Udaipur for providing necessary facilities.

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Received: 02.03.2018 Accepted: 29.05.2018