Forage Res., **50**(1) : pp. 82-86 (2024) **http://forageresearch.in**

ASSESSMENT OF SORGHUM GENOTYPES AGAINST SORGHUM SHOOT FLY, *ATHERIGONA SOCCATA* WITH RESPECT TO MORPHOLOGICAL CHARACTERS

RAJ KUMAR[1], DALIP KUMAR[1]*, BAJRANG LAL SHARMA[1], TARUN VERMA[1], PAVITRA KUMARI[2], VIVEK KUMAR SAINI[3], SUMIT MEHLA[1] AND POOJA YADAV[1]

[1]Department of Entomology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India
[2]Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India
[3]Department of Zoology, Government College, Hisar-125001 (Haryana), India
*(*e-mail: dshroff@hau.ac.in*)
(Received : 10 June 2024: Accepted : 28 June 2024)

SUMMARY

An investigation was carried out during *Kharif*, 2021 at CCS HAU, Hisar to know the reaction of sorghum shoot fly in 40 sorghum genotypes, replicated three times in randomized block design. Deadheart caused by shoot fly varied from 6.23 to 23.94 per cent with mean 15.80 per cent at 21 days after crop emergence and from 11.42 to 43.48 per cent having mean 27.43 per cent at 28 days after crop emergence in 40 sorghum genotypes. Sorghum genotypes categorized in three classes' *i.e,* 1, 2 and 3 on the basis of deadheart formation at 21 DAE, eight (8) genotypes given a score of 1 having deadheart per cent less than 10. At 28 days after crop emergence, all the genotypes lie within a range of 2–5 scale. 14 sorghum genotypes (SH 1936, CSV 33 MF, SH 2026, 467 x SSG, SH 2018, SH 1603, GP 2008, GP 2043, GP 2031, GP 2099, GP 2029, HBM 3, IS 2312 and IS 2205) were assigned a scale rating of 2.0 indicating that the deadheart percentage ranged from 11 to 20 per cent exhibited resistance against shoot fly in the field. Seven (7) genotypes namely; GP 2101, GP 2055, SH 1934, SH 1955, SH 1919, DJ 6514 and Swarna received a 5 scale rating implying a deadheart percentage between 41 and 50 indicating higher affinity of sorghum shoot fly.

Key words: Resistance, screening, shoot fly, sorghum genotypes

Jowar, or *Sorghum bicolor* (L.) Moench, is a member of the Poaceae family. It is a basic food and fodder crop that is farmed all over the world, having originated in North East Africa., sorghum, is a short-day C_4 tillering grass, has a fibrous root structure and grows quickly to a maximum height of five meters (Badigannavar *et al.,* 2018). Because of its ability to withstand extreme temperatures and water scarcity, this crop is climate change compliant (Abreha *et al.,* 2022). In India, sorghum ranks fourth in importance among cereals, behind rice, wheat, and maize (Dehinwal *et al*., 2016). United States of America stands first in sorghum production with 9.4 million tonnes (15%) followed by Nigeria, Ethiopia, Sudan. India ranks fifth in total sorghum production with 3.47 million tones (Anonymous, 2020). In India, a total of 3.47 million tonnes of sorghum grains were produced over the acreage of 4.07 million hectare with productivity of 852.57 kg/ha during 2020 (FAO, 2021) which is well below world's average (1444.6 kg/ha). Major sorghum growing areas in India are states of Maharashtra, Andhra Pradesh, Karnataka, Gujarat, Tamil Nadu and Rajasthan. In Haryana, it is grown mainly for fodder purpose. The sorghum grain is used in many forms as roti or bhakri, malted, popped with several local preparations (Devi *et al.,* 2011).

Absence of improved genotype, weed control, plant protection, fertilizer and irrigation resulted in 39, 33, 31, 30 and 22 per cent losses in the productivity of fodder sorghum as compared to full package of practices during *kharif* season (Satpal *et al*., 2021). According to Verma and Singh (2000), there are about 150 insect pest species that can harm sorghum plants from the time of germination till crop harvest. This is a significant factor to achieve the desired levels of productivity and production for sorghum. Within this heterogeneous group of insect pests, the sorghum spotted stem borer, *Chilo partellus* Swinhoe, shoot fly, *Atherigona soccata* Rondani, ear head bug, *Calocoris angustatus* Leth. and ear head worm, *Cryptoblebes gnidiella* Mab. are some of the few quintessential insect pests that attack sorghum crop at different stages of the crop development (Patidar *et al.,* 2019). While in case of shoot fly, sorghum is highly vulnerable to it's damage in the initial stages of crop growth, particularly the late planted crop *i.e.,* 5 to 25 days after germination as adult fly are active during the morning and evening hours (Patil and Bagde, 2017). In India, *Atherigona soccata* cause losses upto 80-90 per cent in grain yield and 68 per cent in fodder yield (Kahate *et al.,* 2014). A radical change in pest management tactics from a unilateral chemical approach to non-chemical techniques like ecological management, biological control, and host plant resistance has, therefore, become imperative (Kumar et al, 2018). Keeping in the view of importance of resistance in sorghum crop, a field experiment carried out to estimate the sorghum genotypes against sorghum shoot fly, *Atherigona soccata* on the basis of morphological features.

MATERIALS AND METHODS

Experiment was conducted during *Kharif*, 2021 at the research area of Forage Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar, situated at 29.1492°N, 75.7217°E at an elevation of 215 metres above sea level. It falls under agro-climatic zone II where summer temperature prevails as high as 46 degrees Celsius and temperature falls in winter up to1.5 degree Celsius. The Southwest monsoon usually brings showers from July to September with an average of 450 mm. Recommended agronomic practices were followed to raise the healthy crop as per package of practices of CCSHAU for *Kharif* crop except plant protection measures. Forty sorghum genotypes were collected from Forage section, Department of Genetics and Plant Breeding, CCSHAU, Hisar as availed under All India Coordinated Sorghum Improvement Project (AICSIP), International Crop Research Institute for semi-arid tropics (ICRISAT), Hyderabad. Observations on deadheart were made at 21 and 28 DAE in the experimental plots. Based on total number of plants per replication, numbers of plants having deadhearts caused by shoot fly and deadheart (%) was calculated as per following formula.

$$\text{Deadheart (\%) due to shoot fly} = \frac{\text{Number of plants with deadheart}}{\text{Total number of plants observed}} \times 100$$

Statistical analysis

Data of different treatments were analyzed by using OPSTAT software (Sheoran *et al*., 1998).

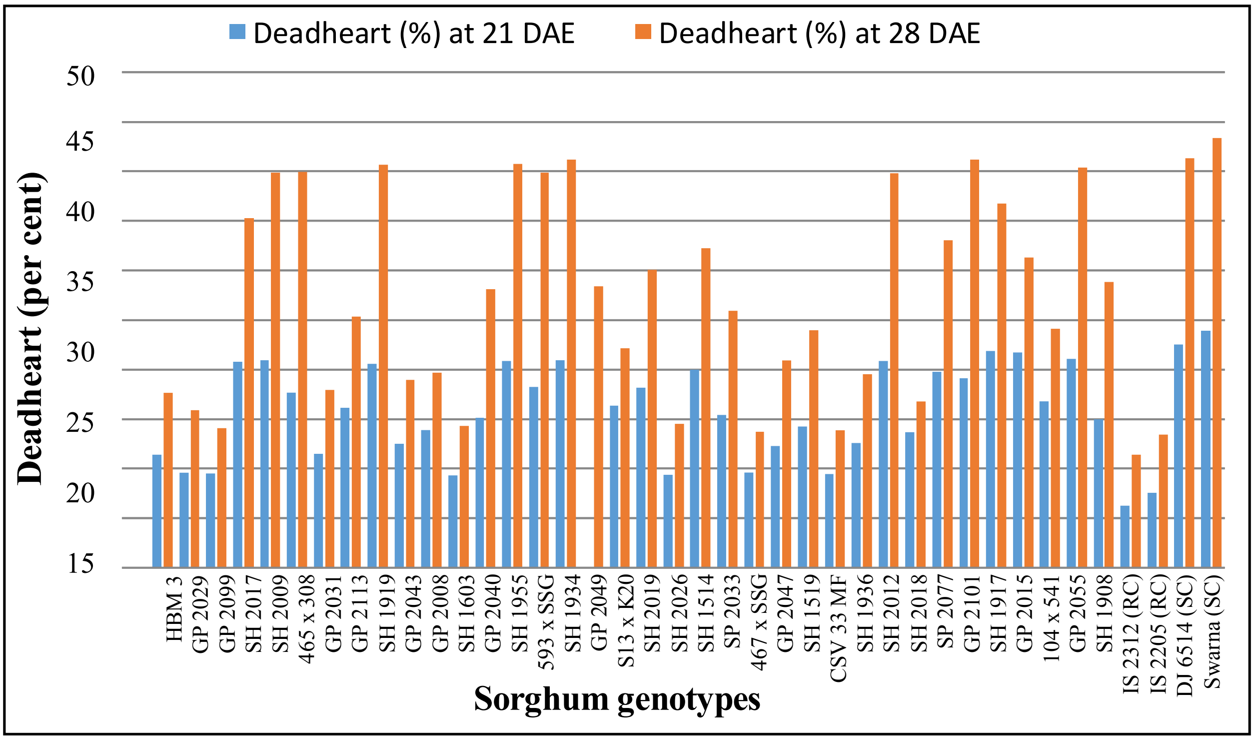

Fig. 1. Deadheart formation (%) in sorghum genotypes by sorghum shoot fly, *Atherigona soccata* at 21 and 28 DAE during *Kharif*, 2021.

RESULT AND DISCUSSIONS

Forty sorghum genotypes were screened during *Kharif,* 2021 to determine their relative resistance and or susceptibility against sorghum shoot fly, *Atherigona soccata* under the natural field infestation conditions, observed on the basis deadheart formation (%) at 21 and 28 DAE and findings are presented as under. None of sorghum genotypes were found free from sorghum shoot fly infestation, at 21 and 28 days after crop emergence.

Deadheart (%) recorded on 21 days after crop emergence (DAE)

Deadheart (%) caused by shoot fly varied from 6.23 to 23.94 per cent with mean 15.8 per cent at 21 days after crop emergence in different sorghum genotypes. Least deadheart *i.e.* 6.23 per cent were noted in check IS 2312; however, deadheart observed in IS 2205 (7.55), SH 1603 (9.34), SH 2026 (9.37), CSV 33MF (9.48), GP 2099 (9.55), GP 2029 (9.57) and 467xSSG (9.57%) were statistically similar with check. Susceptible check, Swarna, showed the maximum (23.94%) deadheart (%) expressing its susceptibility to shoot fly were statistically at par in intensity of deadheart found in genotypes DJ 6514 (22.54), SH 1917 (21.86), GP 2015 (21.73), GP 2055 (21.07), SH 2009 (20.96), SH 1934 (20.94), SH 2012 (20.85), SH 1955 (20.85) and SH 2017 (20.80%) as observed in susceptible check. Remaining genotypes recorded deadheart percentage between 11.44 to 20.57% (Table 1).

Deadheart (%) recorded on 28 days after crop emergence (DAE)

At 28 days after crop emergence, deadheart percentage varied from 11.42 to 43.38 with a mean value of 27.43 per cent. Least deadheart *i.e.* 11.42 per cent were noted in the resistant check IS 2312 which was statistically at par with number of deadhearts formed in IS 2205 (13.44), 467xSSG (13.75), CSV 33MF (13.87), GP 2099 (14.12), SH 1603 (14.30), SH 2026 (14.56) and GP 2029 (15.90%). Susceptible check, Swarna (43.48%), showed the highest deadhearts (Table 1) followed by DJ 6514 (41.32) and were at par with deadheart () in test entries, GP 2101 (41.17), SH 1934(41.17), SH 1955 (40.78), SH 1919 (40.66), GP 2055 (40.37), 465x308 (39.95), SH 2009 (39.90) and SH 2012 (39.81%).

Categorization of sorghum genotypes on the basis of deadheart (%) against sorghum shoot fly, *Atherigona soccata* at 21and 28 DAE

Forty sorghum genotypes were categorized on the basis of scale of 1 to 9 and were constituted only in three classes' *i.e,* 1, 2 and 3. There were 8 genotypes given a score of 1 having deadheart per cent less than 10; 21 genotypes given a rating of 2 having deadheart per cent between 11 and 20; and 11 genotypes assigned rating of 3 that depict deadheart per cent between 21 and 30 (Table 1).

At 28 days after crop emergence, forty sorghum genotypes were categorized into various categories on the basis of a 1-9 scale. All the genotypes

TABLE 1

Categorisation of sorghum genotypes on the basis of deadheart formation at 21 DAE by sorghum shoot fly, *Atherigona soccata* during *Kharif*, 2021

S. No.	Scale (1-9)	Deadheart (%)	No. of Genotypes	Sorghum Genotypes
1.	1	<10	8	GP 2029, GP 2099, SH 1603, SH 2026, 467 x SSG, CSV 33 MF, IS 2312, IS 2205
2.	2	11-20	21	HBM 3, 465 x 308, GP 2031, GP 2113, GP 2043, GP 2008, GP 2040, 593 x SSG, GP 2049, S13 x K20, SH 2019, SH 1514, SP 2033, GP 2047, SH 1519, SH 1936, SH 2018, SP 2077, GP 2101, 104 x 541, SH 1908
3.	3	21-30	11	SH 2017, SH 2009, SH 1919, SH 1955, SH 1934, SH 2012, SH 1917, GP 2015, GP 2055, DJ 6514, Swarna
4.	4	31-40	-	Nil
5.	5	41-50	-	Nil
6.	6	51-60	-	Nil
7.	7	61-70	-	Nil
8.	8	71-80	-	Nil
9.	9	>81	-	Nil

TABLE 2
Categorization of sorghum genotypes on the basis of deadheart formation at 28 DAE by sorghum shoot fly, *Atherigona soccata* during *Kharif*, 2021

S. No.	Scale (1-9)	Deadheart (%)	No. of Genotypes	Sorghum Genotypes
1.	1	<10	0	Nil
2.	2	11-20	14	IS 2205, IS 2312, SH 1936, CSV 33 MF, SH 2026, 467 x SSG, SH 2018, SH 1603, GP 2008, GP 2043, GP 2031, GP 2099, GP 2029, HBM 3
3.	3	21-30	9	GP 2113, GP 2040, GP 2049, S13 x K20, SP 2033, GP 2047, SH 1519, 104 x 541, SH 1908
4.	4	31-40	10	SH 2017, SH 2009,SH 1917, 465 x 308, 593 x SSG, SH 2019, SH 1514, SH 2012, SP 2077, GP 2015
5.	5	41-50	7	Swarna, DJ 6514, GP 2101, GP 2055, SH 1934, SH 1955, SH 1919
6.	6	51-60	-	Nil
7.	7	61-70	-	Nil
8.	8	71-80	-	Nil
9.	9	>81	-	Nil

lie within a range of 2-5 as not any entry fallen in scale 1 owing to higher deadheart incidence *i.e*., >10 %. 14 sorghum genotypes were assigned a scale rating of 2 indicating that the deadheart percentage ranged from 11 to 20. 9 genotypes received a scale rating of 3 in which deadheart per cent was between 21 and 30; 10 genotypes classed in a scale rating of 4 having deadheart per cent between 31 and 40. There are 7 genotypes received a 5 scale rating implying a deadheart percentage between 41 and 50 (Table 2).

Mean deadheart (%) recorded on 21 and 28 DAE

Mean value of deadheart formation (%) recorded by aggregation of values (Table 1) obtained on 21 and 28 days after crop emergence ranged from 8.82 to 33.66 with a mean of 21.79 per cent. Maximum value was recorded in susceptible check Swarna (33.66) followed by DJ 6514 (31.93) and sorghum test entries; SH 1905 (31.05), SH1955(30.81), GP 2055 (30.73), SH 1919 (30.62), 465x 308 (30.45), SH 2009 (30.43), SH 2012 (30.33), GP 2101(30.15), SH 1917 (29.32), 593 x SSG (29.04) and SH 2017 (28.02%) were statistically at par with each other. Resistant check, IS 2312, recorded minimum value of deadheart *i.e.,* 8.82% which was statistically at par with IS 2205 (10.49), 467 x SSG (11.66), CSV 33MF (11.67), SH 1603 (11.82), GP 2099 (11.83), SH 2026 (11.97) and GP 2029 (12.73%). Presnt findings were similar to those of Madavi and Sonalkar (2019) who reported least deadhearts at 14 DAE in IS-18551 (6.08%) followed by IC-288919 (8.68%). Maximum deadhearts i.e. 46.71% observed in IC-288631. Least deadhearts *i.e.,* 14.32% at 21 DAE were noted in IS-18551 while the test entry IC-288631 (51.88) showed highest deadhearts expressing susceptibility to shoot fly in sorghum crop. Similar findings as in current work *i.e.,* screening of sorghum genotypes were also reported by Jakhar *et al*. (2021), Prakash and Karabhantanal (2019), Van den Berg *et al*. (2005), Despande *et al.* (2003) and Kumar *et al.* (2000).

CONCLUSION

Although, 40 sorghum genotypes were categorized on the basis of deadheart formation at 21 DAE, using a scale of 1 to 9 and eight (8) genotypes were assigned a score of 1 having deadheart per cent less than 10 performing as somewhat resistant lines of sorghum. Furthermore, at 28 days after crop emergence, all the genotypes lie within a range of 2–5 indicating a shift of resistance from scale 1 to higher side *i.e.,* 2 may be owing to higher pressure of pest invasion. 14 sorghum genotypes (SH 1936, CSV 33 MF, SH 2026, 467 x SSG, SH 2018, SH 1603, GP 2008, GP 2043, GP 2031, GP 2099, GP 2029, HBM 3, IS 2312 and IS 2205) were assigned a scale rating of 2.0 indicating that the deadheart percentage ranged from 11 to 20 per cent. Seven (7) genotypes namely; GP 2101, GP 2055, SH 1934, SH 1955, SH 1919, DJ 6514 and Swarna received a 5 scale rating implying a deadheart percentage between 41 and 50 exhibiting their higher susceptibility against shoot fly. However, before drawing any conclusion on susceptibility and resistance line of sorghum genotypes against target pest, it needs elaborated and detailed studies on the above aspects.

ACKNOWLEDGEMENTS

All sort of assistance rendered by Director of Research and Head, Forage section, Department of Genetics and Plant Breeding, CSS Haryana Agricultural University, Hisar, India for the above study is gratefully acknowledged.

REFERENCES

Badigannavar A, N. Teme, A.C. de Oliveira, G Li, M Vaksmann, V.E. Viana, T. Ganapathi and F. Sarsu, 2018: Physiological, genetic and molecular basis of drought resilience in sorghum [*Sorghum bicolor* (L.) Moench]. *Indian Journal of Plant Physiology,* **23**(4):670-688.

Abreha, K.B., M. Enyew, A.S. Carlsson, R.R. Vetukuri, T. Feyissa, T. Motlhaodi, D. Nguni, and M. Geleta, 2022: Sorghum in dryland: morphological, physiological, and molecular responses of sorghum under drought stress. *Plantae.* **255** (1): 99-107.

Dehinwal, A.K., S. K. Pahuja and M. Shafiqurrahaman, 2016: Environmental effect on sorghum fodder yield and its related traits. *Forage Research*, **42**(3):189-194.

Deshpande, V. P., M.Y. Kamatar, D.S. Kathnalli, S.M. Malleshappa and N.Y. Nayakar, 2003: Screening of sorghum genotypes against shootfly, *Atherigona soccata* (Rondani). *Indian Journal of Plant Protection*, **31**(1): 90-93.

Anonymous, 2020. Accessed from agricoop.nic.in. Department of Agriculture Cooperation and Farmer Welfare. (accessed on 20th May, 2021).

FAO, 2023: http//www.fao.org/faostat/en/#data (accessed on 20th May, 2023).

Devi P.B., R.S. Vijayabharathi, N.G. Sathyabama and V.B. Priyadarshini, 2011: Health benefits and uses of sorghum and finger millets. *Journal of food sciences and Technology.* **1**(3): 4-9.

Jakhar, A., H. Kumar, P. Kumari, L. Kumar, B.L. Sharma, and G.S. Prasad, 2021: Screening of sorghum genotypes for resistance against *Atherigona soccata* (Rondani) and *Chilo partellus* (Swinhoe) under natural field conditions. *Forage Research,* **47**(1): 113-118.

Patidar, R., S.B. Singh, N. Kamde and R. Patidar, 2019: Reaction of different sorghum hybrids against sorghum insect pest population. *Journal f Entomology and Zoology studies.* **7**(5): 13-21.

Prakash, R.C. and S.S. Karabhantanal, 2019: Evaluation of speciality grain type of *Rabi* sorghum varieties for resistance to major insect pests. *Journal of Farm Sciences,* **32**(4): 447-451.

Kumar, D., Dilbag Singh Ahlawat, Surender Singh Yadav, Deepika Kalkal, Vivek Kumar Saini and Dharmendar Singh, 2018: Phenetic resistance in sugarcane, tentative conclusions and new research directions. *Journal of Entomology and Zoology Studies,* E-ISSN: 2320-7078 P-ISSN: 2349-6800; **6**(4): 999-1003

Kumar, V. K., K. D. Reddy, M. S. Rao and B.U. Singh, 2000: Evaluation of some sorghum genotypes for shoot fly (*Atherigona soccata* Rondani) resistance. *Journal of Research ANGRAU*, 28 (**1/2**): 1-6.

Kahate, N.S., S.M. Raut, P.H. Ulemale and A.F. Bhogave, 2014: Management of sorghum shoot fly. *Popular Kheti,* **2**(1): 72-74.

Madavi, M. G. and V. U. Sonalkar, 2019: Evaluation of sorghum genotypes for their resistance to shoot fly *Atherigona soccata*. *Indian Journal of Entomology*, **81**(3): 558-563.

Patil, S.P. and A.S. Bagde, 2017: Effect of new molecules of insecticides on shoot fly (*Atherigona soccata*) (Rondani) incidence and grain yield of sorghum. *International Journal of Current Microbiology and Applied Sciences,* **6**(1): 2751-2754.

Satpal, S. Kumar, A. Kumar, B. Gangaiah, K. K. Bhardwaj and Neelam, 2021: Evaluation of energy efficiency and optimum resource management in forage sorghum [*Sorghum bicolor* (L.) Moench] under semi-arid tropics. *Forage Res.,* **47**(3): 308-312.

Sheoran, O. P., D. S. Tonk, L. S. Kaushik, R. C. Hasija, and R. S. Pannu, 1998: Statistical software package for agricultural research workers. Recent advances in information theory, statistics and computer application by Hooda, D.S. and Hasija, R.C., Department of Mathematics and Statistics, CCS HAU, Hisar. 139-14.

Van den Berg, J., L. Bronkhorst, M. Mgonja and A.B. Obilana, 2005: Resistance of sorghum varieties to the shoot fly, *Atherigona soccata* Rondani (Diptera: Muscidae) in Southern Africa. *International journal of pest management*, **51**(1): 1-5.

Verma, T., and S.P. Singh, 2000: Multiple resistance in forage sorghum hybrids to the sorghum shootfly, *Atherigona soccata* (Rondani) and the spotted stem borer, *Chilo partellus* (Swinhoe). *International Journal of Tropical Insect Science*, **20**: 203-206.