INTERNATIONAL JOURNAL OF PLANT PROTECTION | VOLUME 7 | ISSUE 1 | APRIL, 2014 | 41-44
e ISSN-0976-6855 | *www.researchjournal.co.in* | Open Access

IJPP

RESEARCH ARTICLE

Development of sorghum shoot fly (*Atherigona soccata Rondani*) resistance in sorghum

■ JAYASHRI N. FOLANE[1], R.B. GHORADE[2] AND D.V. GHIVE[2]*

[1]Department of Biotechnology, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, AKOLA (M.S.) INDIA
[2]Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, AKOLA (M.S.) INDIA

ARITCLE INFO

Received : 22.02.2013
Revised : 28.01.2014
Accepted : 12.02.2014

Key Words :
Sorghum shoot fly, Correlation, Trichome density, *Atherigona soccata*

***Corresponding author:**

ABSTRACT

Evaluate 28 genotype with an aim to assess the correlation study of different sorghum genotypes. A field experiment was conducted to study the relation of different plant characters and shoot fly resistance trait in sorghum *viz.*, pigmentation, Leaf glossiness, seedling with eggs at 14 and 21 day after emergence (DAE), deadheart percentage at 14 and 21 DAE, trichome density (/m^2) and grain yield. The oviposition percentage on 14th and 21st days after seedling emergence exhibited significant positive correlation with dead hearts. Leaf trichome density on abaxial leaf surfaces showed significant negative correlation with shootfly dead hearts. Genotypic correlation confirmed that the number of trichomes on lower surfaces of lamina and leaf glossiness contributed resistance to shoot fly. This help to understand the varying degree of association and contribution of each character in building up total genetic architecture of resistance in CMS (A), Maintainer (B), restorer (R) lines.

How to view point the article : Folane, Jayashri N., Ghorade, R.B. and Ghive, D.V. (2014). Development of sorghum shoot fly *(Atherigona soccata Rondani)* resistance in sorghum. *Internat. J. Plant Protec.*, **7**(1) : 41-44.

INTRODUCTION

Sorghum is [*Sorghum bicolor* (L.) Moench.] one of the most important cereal crops grown in Africa, Asia, USA, Australia and Latin America. Its importance after wheat, maize, rice, barley is because of its good adaptation to a wide range of ecological conditions, low input cultivation and diverse uses (Aruna *et al.*, 2011).It is the first self-pollinated cereal staple crop. Sorghum is an important and widely adapted small-grain cereal grown between 40°N and 40°S of the equator (Doggett, 1988). It is mainly a rainfed crop of lowland, semi-arid areas of the tropics and sub-tropics and a post-rainy season crop grown on residual soil moisture, particularly in India. Sorghum is one of the most important cereal crops in the semi-arid tropics. The yield penalties to sorghum are very high starting from seedling stage to harvest, and are allotted maximally to biotic stresses (Craufurd *et al.*, 1999).

Shoot fly (*Atherigona soccata*) is a major grain yield limiting factor that causes damage when sowings are delayed in rainy season. Shoot flies of the genus *Atherigona* are known to cause 'deadhearts' in a number of tropical grass species and wheat (Pont and Deeming, 2001). The adult fly lays white, elongated, cigar shaped eggs singly on the undersurface of the leaves, parallel to the midrib. After egg hatch, the larvae crawl to the plant whorl and move downward between the folds of the young leaves till they reach the growing point. They cut the growing tip resulting in deadheart formation (Dhillon, 2005). In India, the losses due to shoot fly damage have been estimated to reach as high as 90 per cent of grain, and 45 per cent of fodder yield (Satish *et al.*, 2009).

The early sown crop escapes from shoot fly damage but the late sown crop in most cases is affected. Shoot fly infestation is high when sorghum sowings are staggered due to erratic rainfall distribution which is common in the SAT. Agronomic practices, natural enemies, synthetic insecticides and host plant resistance have been employed for shoot fly management to minimize the losses (Kumar *et al.*, 2008).

The severity of shoot fly infestation can be reduced by good management practices, of which the use of resistant cultivars is the most effective, economical and eco-friendly approach to control the pest. Although many notable successes have been achieved through conventional breeding in the improvement of plant resistance to insects, the breeding process is often slow and laborious, and sufficient levels of resistance have not been achieved due to the quantitative nature of resistance (Tao *et al.*, 2003). However, concerted efforts toward breeding for shoot fly resistance have resulted in some progress, and a number of genotypes with resistance to shoot fly have been identified (Sharma *et al.*, 2003). The economic impact of shoot fly, the improvement of genetic resistance to this pest is one of the major goals in sorghum breeding programes in India (Nagaraj *et al.,* 2005).

To find out the contribution of each character for governing the resistance, it would be necessary to study the correlations of the shoot fly trait are most important.

MATERIAL AND METHODS

Plant material :

The experimental sorghum seed material was sown in late *Kharif* 2011 at sorghum research unit, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola that comprised of 8 male sterile lines with their maintainer (*i.e.* Akms 70 A and B,Akms 30A and B,Akms 85 A and B,Akms 14A and B,Akms 87A and B,Akms 103A and B,Akms 33-105 A and B,Ies 26003A and B and 12 restorer lines (*i.e.* Akr-325,Akr-73,Akr-427,Akr-150,Akr-1031,Akr-492,Akr-456,ICSR 91012-1, ICSR-43689-1, ICSR-91008, ICSR-38116, ICSR-89012) seed was sown in *Kharif*, 2011with three replication. Each line was planted in a single row plot (4m) with row to row and plant to plant spacing of 45 and 15cm, each replication consisted 28 entries. It was deliberately planted late for effective screening of shootfly resistance.

Phenotyping and data analysis :

Phenotypic data on shoot fly resistance was recorded on following component traits, *viz.,* pigmentation, leaf surface glossiness (abbreviated as GS), seedling with eggs per cent (denoted as SE), at 14 and 21 days after seedling emergence (DAE), deadhearts (DH%) at 14 and 21day DAE and leaf surface trichome density on abaxial (lower; TDL) leaf surfaces. pigmentation was assessed at 5 DAE (where 1 plumule or leaf sheath with dark pigment and 5 plumule or leaf sheath with green colour), leaf glossiness was visually scored on a scale of 1–5 scores at 12 DAE [1 = non-glossy (dark green, dull, broad, and drooping leaves and 5 = high glossy (light green, shiny, narrow and erect leaves)] (Apotikar, 2011). Seedling with eggs was recorded by counting the total number of eggs laid on five seedlings at random from each plot. The mean number of eggs per seedling were calculated at 14 and 21 DAE, mean value was calculated by formula (ratio of the number of seedling with eggs/total number of plants * 100). Overall resistance was recorded as the percentage of deadhearts (DH%) caused by shoot fly infestation. To record data on DH per cent, the total number of plants was initially recorded, and the number of plants with deadhearts was subsequently recorded on 14 and 21 DAE. To record data on DH per cent, the total numbers of plants were initially recorded and the numbers of plants with dead hearts were subsequently recorded on 14^{th} and 21st DAE. The mean values of DH per cent (number of dead hearts / total number of plants × 100) were recorded on 14th and 21st DAE. Trichome density was recorded at 14 DAE and 21DAE on the abaxial leaf surface on the central portion of the fifth leaf from the base, in three randomly selected seedlings in each row in each replication as per the procedure outlined by Sharma and Nwanze (1997). Briefly, the leaf segments (~ 2 cm^2) were cleared in acetic acid: alcohol (2 : 1) and transferred to 90 per cent lactic acid in small vials. The leaf segments were then mounted on a slide in a drop of water and observed under stereomicroscope at a magnification of 10X. The number of trichomes on abaxial leaf surface was counted in three microscopic fields at random and expressed as trichome density (no./mm^2).

Statistical analysis :

The phenotypic correlations among different shoot fly component traits as pigmentation, leaf glossiness, seedling with eggs per cent at 14 and 21 DAE, deadheart per cent at 14 and 21 DAE and Trichome density abaxial (lower) surface of lamina were estimated in the field by using standard method and correlation was work out by using standard method suggested by Hays *et al.* (1955).

RESULTS AND DISCUSSION

The phenotypic trait means of the lines population for different shoot fly component traits are given in Table 1. Differences between the lines were significant for all component traits. The wide variation observed among the lines for shoot fly resistance component traits. Phenotypic correlations between the component traits was estimated based on means value of the lines as per Table 1. Resistance to shoot fly was found to be highly correlated with the shoot fly resistance contributing traits.

Pigmentation the correlation study showed that the pigmentation was significant positive correlation between pigmentation and leaf glossiness (r = 0.51**), trichome density (r = 0.41**) and ultimately yield (r = 0.37**) was recorded. Significant negative correlation was recorded between pigmentation and the seedling with egg at 21 DAE (r = -0.39**) and deadheart at 14 DAE and 21 DAE (r = -0.47**, r = -0.47**, respectively). Non-significant negative correlation was with the seedling with egg at 14 DAE (r = -0.34*).

Table 1 : Phenotypic correlations among components of resistance to shoot fly in sorghum A, B and R lines

Trait	Pigmen-tation	Glossiness	Seedling % at 14 DAE	Seedling % at 21 DAE	DH % at 14 DAE	DH % at 21 DAE	Trichome density (/mm^2)	Yield (g/ plant)
Glosssi-ness	0.51**	1						
Seedling % 14 DAE	-0.34*	-0.78**	1					
Seedling % 21 DAE	-0.39**	-0.84**	0.94**	1				
DH % 14 DAE	-0.47**	-0.83**	0.96**	0.95**	1			
DH % 21 DAE	-0.47**	-0.80**	0.96**	0.96**	0.99**	1		
Trichome density (mm^2)	0.41**	0.69**	-0.87**	-0.86**	-0.90**	-0.91**	1	
Yield (g / plant)	0.37**	0.79**	-0.96**	-0.95**	-0.94**	-0.95**	0.88**	1

** indicates significant of value at P=0.01

Glossiness correlation table showed the significantly positive correlation as glossiness and pigmentation (r = 0.51**), trichome density (r = 0.69**) and yield (r = 79**). Significant negative correlation was found in the seedling with egg per cent at 14 and 21 DAE (r = -0.78**, r = -0.84**), respectively, deadheart at 14 and 21 DAE (r = -0.83**, r = -0.80**).

Seedling with Egg 14 DAE data on in the present study was reported significant positively correlated with the seedling with egg at 21 DAE (r = 0.94**), DH at 14 and 21 DAE (r = 0.96**, r = 0.96**, respectively). Significant negative correlation was recorded for seedling with egg per cent at 14 DAE with the trichome density (r = -0.87**) and yield (r = -0.96**). Seedling with egg 21 DAE correlation studies showed that seedlings with egg at 21 DAE were in negatively correlation with trichome density and yield (r = -0.86** r = -0.95**, respectively). While significant positive correlation with deadheart at 14 and 21 DAE (r = 0.95**, r = 0.96**) was reported.

Dead heart per cent at 14 DAE showed the significantly positive correlation with the deadheart at 21 DAE (r = 0.99**) and significant negative correlation was recorded with trichome density and yield (r = -90**, r= -94**, respectively). Dead heart per cent at 21 DAE correlation study showed that deadheart percentage at 21 DAE gave significantly negative correlation with the trichome density (r = -0.91**) and yield (r= -0.95**). Trichome density was exhibited significant positive correlation with the pigmentation and glossiness (r = 0.64**, r = 0.77**) and yield as per Table 1.

Yield significantly positive correlation was reported for yield with pigmentation (r = 0.63), glossiness (r = 0.85**) and trichome density (r = 0.89**).

Studies on phenotypic correlation between the component traits for shootfly resistance was estimated on RIL means. Pigmentation was positively correlated with glossiness, trichome density, while negative associated with oviposition at 14 and 21 DAE, DH at 14 and 21 DAE (Apotiker, 2011).

Highly significant and negative association was observed for trichome density at adaxial surface of leaf lamina and shoot fly damage parameter (oviposition and dead heart) (Gomesh *et al.,* 2010).

Dead heart and oviposition recorded a significant positive correlation (Sharma and Nwanze, 1997; Halalli *et al.*, 1982). Correlation co-efficient of sorghum traits for shoot fly resistance was found significant (Aruna, 2011). Dead heart percentage was negatively associated with the components traits glossiness (r = -0.38**), trichome density (r = -0.39**) and SV (r = -0.35**).

Conclusion :

Correlation study indicated that selection for glossiness and pigmentation would simultaneously result in increased glossiness trichome density and yield and decreased seeding per cent 14 DAE, seeding per cent 21 DAE, DH per cent 14 DAE, DH per cent 21 DAE. Thus, selection made on the basis of glossiness and pigmentation is likely to improve triochme density and yield with minimum dead hearts percentage in shootfly resistant lines.

REFERENCES

Apotikar, D.B., Venkateswarlu, D., Ghorade, R.B., Wadaskar, R.M., Patil, J.V. and Kulwal, P.L. (2011). Mapping of shootfly tolerance loci in sorghum using SSR markers. *J. Genetics,* **90**(1) : 59-66.

Aruna, C., Bhagwat, V.R., Madhusudhana, R., Sharma, Vittal, Hussain, T., Ghorade, R.B., Khandalkar, H.G., Audilakshmi, S. and Seetharama, N. (2011). Identification and validation of genomic regions that affect shootfly resistance in sorghum [*Sorghum bicolor* (L.) Moench]. *Theor. Appl. Genet.,* **122** (8) : 1617–1630.

Craufurd, P.Q., Mahalakshmi, V., Bidinger, F.R., Mukuru, S.Z. Chantereau, J., Omanga, P.A., Qi, A., Roberts, E.H., Ellis, R.H., Summerfield, R.J. and Hammer, G.L. (1999). Adaptation of sorghum: characterisation of genotypic flowering responses to temperature and photoperiod. *Theor. Appl. Genet.,* **99** (5) :900-911.

Dhillon, M.K., Sharma, H.C., Singh, R. and Naresh, J.S. (2005). Mechanisms of resistance to shootfly, *Atherigona soccata* in sorghum. *Euphytica,* **144** (3) : 301-312.

Doggett, H. (1988). *Sorghum*, (2nd edn.) Longman Scientific and Technical / Wiley. New York, pp. 1-12.

Gomashe, S., Misal, M.B., Ganapathy, K.N. and Rakshit, Sujay. (2010). Correlation studies for shootfly resistance traits in sorghum [*Sorghum bicolor* (L.) Moench]. *E. J. Pl. Breeding*, **1**(4) : 899-902.

Halalli, M.S., Gowda, B.T.S., Kulkarni, K.A. and Goud, J.V. (1982). Inheritance of resistance to shootfly (*Atherigona soccata Rondani*) in sorghum [*Sorghum bicolour* (L.) Moench]. *Sabrao J*., **14** : 165-170.

Hayes, H.K., Immer, F.R. and Smith, D.C. (1955). *Methods of plant breeding*. Mc. Grow Hill Book Company, New York, U.S.A.

Kumar, A.A., Reddy, B.V.S., Sharma, H.C. and Ramaiah, B. (2008). Shootfly (*Atherigona soccata*) resistance in improved grain sorghum hybrids. *E-J. SAT Agric. Res*., **6** : 1–4.

Nagaraj, N., Reese, J.C., Tuinstra, M.R., Smith, C.M., Amand, P.S., Kirkham, M.B., Kofoid, K.D., Campbell, L.R. and Wilde, G.E. (2005). Molecular mapping of sorghum genes expressing tolerance to damage by greenbug (Homoptera: Aphididae). *J. Econ. Entomol*., **98**(2) : 595-602.

Pont, A.C. and Deeming, J.C. (2001). A shoot fly, *Atherigona tritici* sp. n. (Diptera : Muscidae), attacking wheat (*Triticum aestivum*) in Egypt. *Bull. Entomol. Res.*, **91**(4) : 297-300.

Satish, K., Srinivas, G., Madhusudhana, R., Padmaja, P.G., Reddy, R.N., Mohan, S.M. and Seetharama, N. (2009). Identification of quantitative trait loci for resistance to shootfly in sorghum [*Sorghum bicolor* (L.) Moench]. *Theor. Appl. Genet.*, **119**(8): 1425-1439.

Sharma, H.C. and Nwanze, K.F. (1997). Mechanisms of resistance to insects in sorghum and their usefuless in crop improvement. International Crops Research Institute for the Semi -Arid Tropics. Patancheru, A.P. (INDIA) p. 56.

Sharma, H.C., Taneja, S., Rao, N.K. and Prasad Rao, K.E. (2003). Evaluation of sorghum germplasm for resistance to insect pests. Information bulletin no. 63. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, A.P. (INDIA) pp. 17-27.

Tao, Y.Z., Hardy, A., Drenth, J., Henzell, R.G., Franzmann, B.A., Jordan, D.R., Butler, D.G. and Melntyre, C.L. (2003). Identifications of two different mechanisms for sorghum midge resistance through QTL mapping. *Theor. Appl. Genet.*, **107** (1): 116–122.

7th Year
★★★★★ of Excellence ★★★★★