

Evaluation of Some Local Sorghum Checks Resistant to Shoot Fly (*Atherigona soccata* Rondani) and Stem Borer (*Chilo partellus* Swinhoe)

V.R. Bhagwat^{1*}, G. Shyam Prasad¹, A. Kalaisekar¹, B. Subbarayudu¹, T. Hussain², S.N. Upadhyaya³, D.G. Daware⁴, R.G. Rote⁵ and V. Rajaram⁶

¹Directorate of Sorghum Research (DSR), Rajendranagar, Hyderabad 500 030, India

²Maharana Pratap University of Agriculture and Technology, Udaipur 313 001, India

³Rajmata Vijayaraje Sindia Krishi Vishwa Vidyalyaya, Gwalior 474 002, India

⁴Marathwada Agricultural University, Parbhani 431 402, India

⁵Navasari Agricultural University, ARS, Surat 395 007, India

⁶Tamil Nadu Agricultural University, ARS, Kovilpatti 628 501, India

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Abstract: Experiments were conducted to evaluate sorghum checks for resistance to shoot fly and stem borer at the Directorate of Sorghum Research, Hyderabad, and AICSIP centers (Surat, Udaipur, Indore, Coimbatore and Parbhani) during kharif 2007, 2008 and 2009. Taking into consideration six parameters viz., glossiness, seedling vigor, shoot fly deadhearts, stem borer deadhearts, tunnelling and exit holes/stalk due to borer, hierarchical clustering was done by centroid method. Three entries viz., IS 2312, IS 18551 and IS 2205 (resistant checks) were resistant and seven entries viz., JJ1041, PVK 809, CO 28(S), CSV 15, SPV 1616 and CSV 17 were moderately resistant to shoot fly and stem borer indicating multiple resistance.

Key words: Sorghum, key pests, host plant resistance, local checks.

Sorghum is the third most important cereal crop in India after rice and wheat. It is a major food crop for millions of people in the semi-arid tropics. It is primarily grown under subsistence farming conditions and the average grain yield is 0.5-0.9 t ha⁻¹ (Anonymous, 1999). Lower yields of sorghum have been attributed to a number of factors; among them the loss caused by the insect pests is the major one. Nearly 150 insect species have been reported as pests on sorghum in different agro-ecosystems (Jotwani, 1981).

Among the major insect pests, the sorghum shoot fly (*Atherigona soccata* Rondani) and stem borer (*Chilo partellus* Swinhoe) are the most destructive ones. Jotwani (1981) reported that the conventional methods for control of shoot fly were not cost effective. The resistant cultivars become realistic alternative to chemical control. Considerable progress has been made in screening and breeding sorghum resistant to insects, but levels of resistance to multiple insect species are low to moderate (Sharma *et al.*, 2003). The sorghum crop experiences severe damage by two or more insect pests during the crop-growing season. Since most of the area under sorghum is rainfed, chemical control measures alone may not be feasible and economical. Under these circumstances breeding

varieties with moderate level of resistance to key pests like shoot fly and stem borer is appropriate.

Materials and Methods

The experiments were conducted at the Directorate of Sorghum Research, Hyderabad, and AICSIP centers (Surat, Udaipur, Indore, Coimbatore and Parbhani) during kharif 2007-09. The experimental material consisted of six regional sorghum varieties popularly grown in Hyderabad, Surat, Udaipur, Indore, Coimbatore and Parbhani along with three pest resistant checks (IS 2205, 2313, 18551), and one pest susceptible check (DJ 6514). Two separate plots were sown, one each for shoot fly and stem borer. The origin and development of the materials have been detailed in Table 1.

A basal dose of ammonium phosphate (150 kg ha⁻¹) was applied to all experimental plots before sowing. Each entry was sown in two rows of 4 m length each, and the rows were spaced 60 cm apart. There were three replications in randomized complete block design. The seeds were hand sown at 5 cm depth below the soil surface.

The field was irrigated immediately after sowing early in the rainy season. One week after seedling emergence, the plants were thinned to a spacing of 10 cm between the plants. No insecticide was applied in the experimental plots. Interculture

*E-mail: bhagwat@sorghum.res.in

Table 1. Details of the regional sorghum varieties evaluated at DSR, Hyderabad, AICSIP centers (Surat, Udaipur, Indore, Coimbatore, and Parbhani)

Variety	Pedigree	Centre
GJ 38 (SR 202)	GJ 35 x E 35-1	Surat
CSV 17	SPV 946 x SPV 772	Udaipur
JJ 1041	SPV 475 (IS 12622c X555) (IS 3612c x 2219B) x E-35-1-5-2) x SPV 462 (MS 8271x IS 3691)	Indore
PVK 809 (SPV 1474)	Sel from (PVK 801x PVK 881), PVK 801= Sel form GDLP 34553 PVK 881=(SPV 544x SPV 462), SPV 544=(CO 18 X CO 22) SPV 462= (MS 8271 X IS 3691)	Parbhani
CSV 15	SPV 475 X SPV 462	Hyderabad
SPV 1616 (CSV 20)	SPV 946 X KH 89-246	Hyderabad
CO 28 (S)	CO25 x SPV 942	Coimbatore
IS 2312	Selection from Sudan	Check
IS 18551	Selection from Ethiopia	Check
IS 2205	-	Check
DJ 6514	Selection Dharwad Jola 6514	Check

and earthing up operations were carried out at 15 and 30 days after seedling emergence (DAE), respectively. Top dressing was carried out with urea (100 kg ha⁻¹) before earthing up at 30 DAE. Hand weeding was carried out as and when required. Need-based irrigation was applied to the experimental plots.

Interlard fish-meal technique was used to test the material for resistance to sorghum shoot fly (Soto, 1974). For spotted stem borer, the material was infested artificially with insects reared in the laboratory. Eighty grams of poppy seed was mixed with larvae that emerged from 300 egg masses of *C. partellus* in a bazooka applicator (each egg mass contained 30-40 eggs). Each plant in entry was artificially infested with neonate larvae between 0800 h and 1100 h at 20 DAE (Sharma *et al.*, 1992). Resistance to shoot fly and stem borer was recorded in separate experimental plots.

Data were recorded on the number of plants with sorghum shoot fly deadhearts at 28 DAE and expressed as percentage of the total number of plants. Spotted stem borer damage was recorded in terms of percentage deadhearts 3 weeks after artificial infestation. The observations were recorded on plants for deadhearts, number of exit holes per stalk and stem tunnelling, caused by *C. partellus*. The parameters viz., glossiness and seedling vigor were also recorded (Sharma, 1997).

Data were subjected to analysis of variance and the significance of differences between the genotypes was adjudged by F-test, while

the treatment means were compared by least-significant difference (LSD) at P (0.05).

Results and Discussion

Glossiness

There was significant difference between the resistant checks and varieties (Table 2). The glossiness score ranged from 2.3 to 5.0, the mean being 4.1. The entries CSV 17, JJ 041, CSV 15 and CO 28 (S) were at par with resistant checks. The entries SPV 1616, PVK 809 and GJ 38 recorded score of 4.1, 4.3 and 4.5, respectively, and were significantly different than the resistant (IS 2312, IS 18551, IS 2205) and susceptible check (DJ 6514). The glossy trait, is a characteristic of most of the rabi sorghum varieties associated with shoot fly resistance (Taneja and Leuschner, 1985; Omori *et al.*, 1988). The intensity of glossiness of the leaves at seedling stage is positively associated with resistance to shoot fly (Sharma *et al.*, 1997).

Seedling vigor

There was significant difference in seedling vigor between the resistant checks and varieties (Table 2). The seedling vigor ranged from 2.2 to 5.0, the mean being 3.6. None of the entries was at par with resistant checks (IS 2312, IS 18551, IS 2205), which recorded scores of 2.3, 2.2 and 2.4, respectively. The entries PVK 809, CSV 15, JJ 041, GJ 38, CSV 17, SPV 1616 and CO 28 (S) were superior to the susceptible check (DJ 6514). Faster seedling growth and longer shoot length causes the larvae to

Table 2. Reaction of regional sorghum varieties to shoot fly and stem borer (kharif 2007-09)

Entry	Glossiness (1-5)*	Seedling vigor (1-5)*	Shoot fly DH% at 28 DAE	Stem borer		
				DH% at 45 DAE	Stem tunnelling (%)	Exit holes/stalk (no.)
GJ 38	4.5	4.2	58.2	24.3	12.6	4.6
CSV 17	4.7	4.3	57.9	12.2	8.5	3.7
JJ 1041	5.0	4.1	61.6	25.3	14.6	6.2
PVK 809	4.3	3.2	59.0	28.2	17.2	6.9
CSV 15	5.0	3.3	53.2	15.4	9.2	3.8
SPV 1616	4.1	4.3	50.4	18.1	7.8	5.1
CO 28(S)	5.0	4.6	55.9	31.9	15.4	7.6
IS 2312	2.4	2.3	37.4	13.2	5.2	3.2
IS 18551	2.3	2.2	40.3	15.2	4.7	2.8
DJ 6514	5	5	63.1	42.2	24.5	8.5
IS 2205	2.6	2.4	41.2	11.7	3.9	2.4
Mean	4.1	3.6	52.6	21.6	11.2	5.0
Max	5.0	5.0	63.1	42.2	24.5	8.5
Min	2.3	2.2	37.4	11.7	3.9	2.4
CD (0.05)	0.3	0.2	5.6	7.6	5.2	1.5
CV (%)	13.7	10.5	20.5	21.5	25.3	26.8

* Indicates rating 1-best, 5-poor

take more time to reach the base of the shoot. Rapid seedling growth and long, thin seedling leaves make plants less susceptible to shoot fly (Singh, 1998). Faster seedling growth and toughness of the leaf sheath are associated with resistance to shoot fly (Kamatar and Salimath, 2003).

Shoot fly deadhearts

The shoot fly deadhearts (DH) recorded at 28 DAE ranged from 37.4 to 63.1% and the mean damage was 52.5%. All the test entries were inferior compared to checks (IS 2312, IS 18551 and IS 2205), which registered lower shoot fly infestations of 37.4, 40.3 and 41.2% DH, respectively. The local entries recorded high shoot fly infestations in range of 50.4 to 61.6% DH. The entries CSV 17, GJ 38, PVK 809 and JJ 1041 were statistically at par with susceptible check (DJ 6514), which recorded 63.1% DH. The entries SPV 1616, CSV 15 and CO 28(S) recorded moderate levels of infestation (Table 2). None of the entries was comparable to resistant checks (IS 2312, IS 18551). Deadheart has been reported as a stable parameter to ascertain resistance (Singh *et al.*, 1968). The results indicated that oviposition non-preference (antixenosis), and antibiosis components of the resistance play major role in oviposition and DH formation. The primary mechanism of resistance to sorghum shoot fly, which has been observed to be non-preference for oviposition and perhaps a low level of antibiosis to the larvae (Young, 1972). The antixenosis is not stable and breaks down under no-choice conditions or under heavy shoot fly

pressure in the field (Sharma *et al.*, 1997). Most of the entries were highly susceptible indicating poor variability in the entries. Retardation of growth and development, prolonged larval and pupal periods and poor emergence of adults on resistant varieties provide direct evidence of antibiosis (Dhillon *et al.*, 2005). The larvae on the resistant varieties were sick and smaller as compared to those on susceptible sorghum varieties. Resistance to shoot fly is quantitatively inherited (Agrawal and Abraham, 1985) and polygenically controlled (Halalli *et al.*, 1983). Both additive and non-additive gene actions were involved in the shoot fly resistance (Nimbalkar and Bapat, 1992).

Stem borer deadhearts

There was significant difference among the entries. Deadhearts ranged from 11.7 to 42.2% and the mean damage was 21.6%. The entries CSV 17, IS 2312, IS 18551, CSV 15 and SPV 1616 were at par with the resistant check (IS 2205), which recorded 11.7% DH. The entries GJ 38, JJ 1041, PVK 809 and CO 28 (S) recorded moderate levels of infestation. None of the entries was at par with the susceptible check (DJ 6514), which recorded 42.2% DH (Table 2). DH has been reported as stable parameter for ascertaining resistance indicating antibiosis. The major mechanism of resistance to stem borer in sorghum is antibiosis (Singh and Rana, 1984). Lal and Pant (1980) indicated the presence of high larval mortality in larvae feeding on resistant cultivars indicating presence of antibiosis. Pathak and Olela (1983) reported that resistance to *C. partellus* for

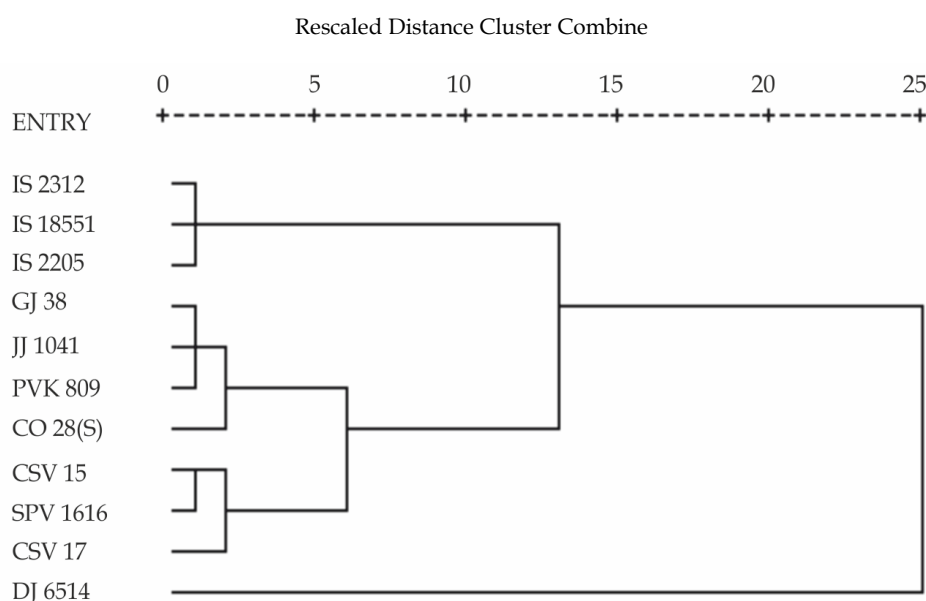


Fig. 1. Dendrogram using centroid method depicting reaction to Shoot fly and Stem borer (kharif 2007-09).

deadhearts was governed by both additive and non-additive type of gene actions while resistance for stem tunnelling was governed predominantly by additive gene action. It was also noted that the inheritance pattern of DH and stem tunnelling was different.

Stem tunnelling

The stem tunnelling due to borer was expressed as proportion of stem tunnelled. The tunnelling ranged between 3.9 to 24.5% and the mean tunnelling was 11.2%. There was significant difference in tunnelling of the stem. The entries IS 18551, IS 2312, SPV 1616 and CSV 17 were at par with resistant check (IS 2205) which recorded 3.9% stem tunnelling. The entries SCV 15, GJ 38, JJ 1041, CO 28 (S) and PVK 809 showed moderate reaction to borer in terms of stem tunnelling (Table 2). Stem tunnelling is reported as a good indicator of the degree of plant damage and is directly proportional to the yield loss (Bosque Perez and Mareck, 1991; Van den Berg and Van Rensburg, 1991; Kalule *et al.*, 1994).

Exit holes per stalk

Significant difference existed among the entries in the number of exit holes made by borer. The damage ranged from 2.4 to 8.5 holes per stalk, the mean damage was 5.0 holes per stalk. The entries IS 18551, IS 2312, CSV 17 and CSV 15 recorded significantly less exit holes per stalk than resistant check (IS 2205), which recorded 2.4 holes per stalk. The entry CO 28 (S) was at par with susceptible

check (DJ 6514) while GJ 38, SPV 1616, JJ 1041 and PVK 809 were moderate in reaction in terms of exit holes/stalk (Table 2). In case of sugar cane stalk borer, *Chilo sacchariphagus*, the percentage of bored stalks was identified as cost effective measure of damage for resistance assessment (Nibouche and Tibere, 2008).

The identification of multiple pest resistant sources in sorghums usually arrived is based on parameters viz., DH formed due to shoot fly, borer, stem tunnelling and exit holes per stalk caused by borer. Apart from these, some plant characters like seedling vigor and glossiness serve as traits for pest resistance. It is most likely that all these characters are not pronounced in resistant cultivars. High stem tunnelling of the resistant cultivar with less or no DH symptoms have been observed (Prem Kishore, 1991). Low DH with relatively high stem tunnelling or vice-versa are reported indicating their independent inheritance (Prem Kishore, 1983, 1986).

Hence, taking into consideration six parameters viz., glossiness, seedling vigor, shoot fly deadhearts, stem borer deadhearts, tunnelling and exit holes/stalk due to borer, hierarchical clustering was done by centroid method. The dendrogram based upon the six parameters grouped the entries into three discrete categories viz., resistant, moderately resistant and susceptible. Three entries viz., IS 2312 IS 18551 and IS 2205 (resistant checks) are resistant and seven entries viz., JJ1041, PVK 809, CO 28(S), CSV 15, SPV 1616 and CSV 17 are moderately

resistant. The entry DJ 6514 (Susceptible check) was susceptible, to shoot fly and stem borer (Fig. 1).

The study indicated that most of the commonly cultivated regional sorghum varieties in the present study possessed moderate levels of multiple pest resistance against shoot fly and stem borer, which is desirable. This could have been the reason for popularity of these lines among the farmers. It is amply proved that none of the entry is released from All India Coordinated Sorghum Improvement Program unless it possesses at least moderate level of resistance against key pests.

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