Stability of Resistance in Sorghum to *Calocoris angustatus* (Hemiptera: Miridae)

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ABSTRACT Eight sorghum genotypes were evaluated for resistance to *Calocoris angustatus* Lethiery (Hemiptera: Miridae) at three infestation levels (5, 10, and 15 pairs of adult bugs per panicle) over six seasons (1984–1987) under no-choice conditions in the head cage. 'IS 17610', and 'IS 17645' had significantly lower bug population increase as compared with the susceptible controls 'CSH 1', 'CSH 5,' and 'CSH 9'. These genotypes also suffered less grain damage and percentage loss in grain mass and showed higher seed germination than the susceptible controls. 'IS 2761' and 'IS 9692' generally had lower bug numbers, but suffered higher grain damage, showed poor seed germination, or both. Bug population increases did not differ significantly across infestation levels. However, grain damage and loss in grain mass was lower in panicles infested with five pairs per panicle. Among the commercial hybrids, 'CSH 9' was more susceptible as compared with 'CSH 1' and 'CSH 5'. 'IS 17610' was the most resistant and stable genotype over seasons and at different infestation levels. 'IS 17618' and 'IS 17645' were relatively unstable and their regression coefficients were significant across infestation levels in some seasons. The results suggested that environmental conditions play an important role in determining the interaction between the insects and the host plant.

KEY WORDS Insecta, *Calocoris angustatus*, plant resistance, sorghum

THE BUG *Calocoris angustatus* Lethiery (Hemiptera: Miridae) is one of the most destructive pests of grain sorghum, *Sorghum bicolor* (L.) Moench, in India (Ballard 1916). Host-plant resistance is an important component in integrated pest management to keep these bug populations below economic injury levels (Sharma 1985).

The identification of sources of resistance under natural infestation is a long-term process because of variations in *C. angustatus* populations over time and the staggered flowering of sorghum genotypes. To overcome this problem, we have developed a head cage technique to screen for host-plant resistance under uniform insect pressure and no-choice conditions (Sharma et al. 1988). However, *C. angustatus* population increase under the head cage and consequent grain damage are influenced by the prevailing environmental conditions. Bug population increases and grain damage are higher during the rainy season than after the rainy season (Sharma 1985). To a large extent, environmental changes within and across seasons influence the genotypic resistance to insects in several crops.

Stability of resistance is of prime importance in stabilizing crop yields across a wide range of environments and insect densities (Faris et al. 1979). Eberhart and Russell (1966) developed a method of measuring genotypic stability across environments. They showed that both the regression coefficient and the deviations from regression of a cultivar on the environmental indices serve as a useful parameter for measuring stability of a cultivar. This approach has been used for testing stability of resistance in sorghum to the midge *Contarinia sorghicola* Coquillett across seasons (Sharma et al. 1988) or a range of sowing dates with varying insect densities (Faris et al. 1979). We studied the stability of resistance to *C. angustatus* across three infestation levels (pest densities) over six seasons.

Materials and Methods

Crop. Eight sorghum cultivars including 5 lines ('IS 17610', 'IS 17618', 'IS 17645', 'IS 2761', and 'IS 9692') identified as less susceptible to *C. angustatus* under natural conditions (Sharma 1985), and three commercial sorghum hybrids ('CSH 1', 'CSH 5', and 'CSH 9') were tested for resistance to the bugs under no-choice conditions in the head cage. The cultivars were planted in eight rows (4 m long, 75 cm apart) in a randomized complete-block design. There were three replications. Plants were thinned to a 10-cm spacing, 15 d after emergence. Seeds were sown with carbofuran granules (1.2 kg [AI]/ha) to control sorghum shoot fly (*Atherigona soccata* Rondani). No insecticide was applied during the reproductive phase of the crop. The crop was raised during the rainy season (June–October) and under irrigation after the rainy season (December–April).

Insects. Adult bugs for infestation were collected in muslin cloth bags from sorghum panicles at the milk stage. Sorghum panicles at this stage have many newly emerged adults. The insects were taken

Table 1. Population increase of *Calocoris angustatus* in eight sorghum genotypes under head cage (ICRISAT Center, 1984–1987)

Genotype	No. bugs/panicle ($\sqrt{n}$)[a]					
	Rainy season			After rainy season		
	1984	1985	1986	1984–1985	1985–1986	1986–1987
'IS 2761'	10.4	—	6.6	7.8	11.0	8.1
'IS 9692'	12.3	8.2	7.5	7.9	12.3	8.9
'IS 17610'	7.5	4.9	6.2	4.2	13.9	6.8
'IS 17618'	14.1	4.1	6.3	6.9	24.6	12.3
'IS 17645'	12.4	5.7	6.7	4.4	11.5	7.9
'CSH 1'	17.1	11.3	—	8.4	20.6	18.2
'CSH 5'	—	15.5	18.7	13.8	23.3	20.4
'CSH 9'	12.0	12.7	15.7	9.6	21.3	17.3
$\bar{x}$ ± SEM	12.3 ± 0.75	8.8 ± 0.50	9.7 ± 0.70	7.9 ± 0.62	17.4 ± 0.64	12.5 ± 0.53
LSD[b]	1.88	1.53	2.10	4.40	1.42	1.63
F value[c]	15.74*	75.20*	55.37*	25.06*	77.00*	102.00*
DF	77	42	40	90	143	48

[a] Means across infestation levels.
[b] LSD, least significant difference for comparing treatment means at $P < 0.05$.
[c] *, F value significant at $P < 0.05$.

to the laboratory and separated into pairs (males and females) of 5, 10, and 15 in 200-ml plastic bottles with the help of an aspirator. These bugs were then taken to the field and were released in the head cages covering panicles at the pre-anthesis stage using the technique of Sharma et al. (1988). Five to ten randomly selected panicles were caged in each genotype. Bug population increases in the head cages were recorded 20 d after infestation.

Grain Damage. Damage by *C. angustatus* was evaluated visually on a 1–5 scale (1, grain fully developed with a few feeding punctures; 2, grain showing slight shriveling and browning because of feeding; 3, 30–40% grain with feeding punctures and shriveling; 4, most grain with feeding punctures and >50% grain shriveled; and 5, grain with extensive feeding and >75% shriveling). Infested panicles were rated for grain damage at maturity.

Another criterion used to evaluate damage was the percentage loss in grain mass. Loss in grain mass (percent) in infested panicles was calculated in relation to the average grain mass per panicle in five undamaged (noninfested) panicles of the respective cultivars. The protected panicles were covered with muslin cloth bags at panicle emergence to prevent oviposition and grain damage by wild bugs. The threshed and dried grain from infested and control panicles was weighed and then percentage loss in grain mass was calculated as described above.

Seed germination was used as another criterion to evaluate the extent of damage. One hundred seeds taken at random from each replication after harvest were germinated between the folds of moist filter paper in a Petri dish at 27°C. The filter paper was moistened every 24 h. Germinated seeds were recorded after 72 h. Seed from noninfested panicles was similarly tested to estimate the seed viability in each genotype.

Statistical Analysis. Bug numbers were converted to square root values. Data on bug numbers and damage rating across infestation levels within a year were averaged, and then analyzed as a randomized complete block to get an overall estimate of genotypic resistance to bugs. Similarly, bug numbers and damage rating at a particular level of infestation were averaged across years and analyzed as a split-plot design to get an estimate of interaction between genotypes and infestation levels. Data on loss in grain mass and seed germination were subjected to analysis of variance using a split-plot design, and correlation coefficients were computed between different parameters. Treatment means were compared by the least significant difference (LSD) test (Snedecor & Cochran 1967). Stability of the genotypes for *C. angustatus* resistance was determined by the method of Eberhart and Russell (1966).

Results and Discussion

Population Increase. There were significant differences in mean bug population increases between the genotypes over seasons (Table 1) and across infestation levels (Table 2). Bug numbers were significantly lower ($P < 0.05$) on 'IS 17610' and 'IS 17645' (except in the 1984 rainy season) than on the susceptible controls 'CSH 1', 'CSH 5', and 'CSH 9'. Population increase in 'IS 2761', 'IS 9692', and 'IS 17618' was significantly lower than in the susceptible controls in three seasons, and was not significantly different from 'CSH 1' and 'CSH 9' in other seasons. These genotypes are therefore considered unstable for their resistance to bugs over seasons. Lower bug counts in the susceptible controls in some seasons may be attributed to bug mortality because of a fungal disease or high rainfall. Factors affecting panicle size or grain yield also influence bug numbers indirectly (Sharma 1985).

Calocoris angustatus numbers over seasons ranged from 55 to 302 bugs per panicle. Bug pop-

Table 2. Population increase of *Calocoris angustatus* in eight sorghum genotypes across three levels of infestation under head cage (ICRISAT Center, 1984–1987)

Genotype	No. of bugs/panicle after infestation with			Mean
	5 pairs	10 pairs	15 pairs	
'IS 2761'	78 (8.7)[a]	79 (8.9)[a]	54 (7.3)[a]	70 (8.3)[a]
'IS 9692'	141 (11.3)	110 (10.2)	63 (7.9)	105 (9.8)
'IS 17610'	50 (6.4)	77 (7.9)	78 (8.2)	68 (7.5)
'IS 17618'	187 (11.4)	157 (11.0)	199 (12.2)	181 (11.5)
'IS 17645'	72 (8.2)	76 (8.1)	89 (8.5)	79 (8.3)
'CSH 1'	298 (15.4)	246 (15.3)	295 (16.0)	280 (15.6)
'CSH 5'	272 (16.4)	384 (19.6)	443 (20.6)	366 (18.9)
'CSH 9'	248 (15.4)	243 (15.1)	252 (15.2)	247 (15.3)
Mean	168 (11.7)	171 (12.0)	184 (12.0)	175 (11.9)

Mean of data from six seasons.
[a] Figures in parentheses are square root values.
Degrees of freedom (df), F value, standard error of mean (SEM), and least significant difference (LSD) at $P < 0.05$ for comparing genotypes are 7, 18.17, 0.90, and 2.34, respectively; for infestation levels, the df, F value, SEM, and LSD are 14, 0.40, 0.31, and 1.33, respectively; and for genotypes × infestation levels, the df, F value, SEM, and LSD are 73, 1.80, 1.22, and 2.62, respectively.

ulation increases were significantly lower ($P < 0.05$) in 'IS 2761', 'IS 9692', 'IS 17610', 'IS 17618', and 'IS 17645' (50–199 bugs/panicle) compared with the susceptible controls 'CSH 1', 'CSH 5', and 'CSH 9' (272–443 bugs/panicle) across infestation levels (Table 2). Bug numbers were not significantly different across infestation levels, except in 'CSH 5', where a significant increase was recorded at 10 pairs/panicle. In some genotypes, bug numbers were slightly lower when the panicles were infested with 15 pairs per panicle. Among the susceptible hybrid controls, most bugs were recorded on 'CSH 5', followed by 'CSH 1' and 'CSH 9'. Mean bug population increase across infestation levels was not significantly different at $P < 0.05$.

Grain Damage. Grain damage rating was significantly lower ($P < 0.05$) in 'IS 17610', 'IS 17618', and 'IS 17645' compared with the susceptible controls, 'CSH 1', 'CSH 5', and 'CSH 9' (Table 3). 'IS 2761' and 'IS 9692' suffered considerable grain damage, although population increase was relatively lower on these genotypes. Mean damage rating varied from 3.5 to 4.1 over seasons. Grain damage was significantly lower in 'IS 17610', 'IS 17618', and 'IS 17645' across infestation levels (damage rating 2.7–3.4) than in the susceptible controls 'CSH 1', 'CSH 5', and 'CSH 9' (damage rating >4.1) (Table 4). 'IS 2761' and 'IS 9692' suffered higher grain damage across infestation levels (damage rating 3.2–4.9) and were not significantly different from the susceptible controls 'CSH 1', 'CSH 5', and 'CSH 9' (damage rating 3.6–5.0). Bug population increases were lower on these cultivars, which may be because of antibiosis or the low number of grains available for growth and development (Sharma 1985). Among the susceptible controls, 'CSH 9' was most susceptible, followed by 'CSH 5' and 'CSH 1'. Grain damage was significantly lower ($P < 0.05$) in panicles infested with five pairs of bugs per panicle compared with those infested with 10 or 15 pairs of bugs per panicle. Genotype × infestation level interaction was significant at $P < 0.05$.

Loss in Grain Mass. 'IS 17610', 'IS 17618', and 'IS 17645' suffered <40% loss in grain mass across

Table 3. Grain damage in eight sorghum genotypes under no-choice screening in head cage (ICRISAT Center, 1984–1987)

Genotype	Damage rating[a]					
	Rainy season			After rainy season		
	1984	1985	1986	1984–1985	1985–1986	1986–1987
'IS 2761'	4.6	—	4.6	3.9	3.1	4.4
'IS 9692'	4.2	3.3	4.3	4.7	4.7	4.4
'IS 17610'	2.6	2.3	3.2	2.1	3.4	3.2
'IS 17618'	3.7	2.6	3.1	3.1	3.4	3.5
'IS 17645'	3.2	2.8	3.3	2.8	3.3	3.5
'CSH 1'	4.9	4.6	—	3.5	4.3	4.6
'CSH 5'	—	4.3	4.6	4.1	4.2	4.8
'CSH 9'	4.5	4.8	4.4	4.8	5.0	4.9
$\bar{x}$ ± SEM	4.0 ± 0.11	3.5 ± 0.11	3.9 ± 0.15	3.6 ± 0.15	3.9 ± 0.08	4.1 ± 0.14
LSD[b]	0.27	0.35	0.26	0.71	0.18	0.41
F value	54.90*	81.12*	27.37*	39.35*	70.56*	23.81*
DF	77	42	60	90	143	71

*, Significant at $P < 0.05$.
[a] Means across infestation levels. Grain damage rated visually on a 1–5 scale.
[b] LSD, least significant difference for comparing treatment means at $P < 0.05$.

Table 4. Grain damage in eight sorghum genotypes at three levels of infestation with *Calocoris angustatus* under head cage (ICRISAT Center, 1984–1987)

Genotype	Damage rating[a] after infestation with			Mean
	5 pairs	10 pairs	15 pairs	
'IS 2761'	3.2	4.4	4.5	4.0
'IS 9692'	3.9	4.6	4.9	4.5
'IS 17610'	2.7	3.0	3.0	2.9
'IS 17618'	3.2	3.0	3.0	3.3
'IS 17645'	3.0	3.4	3.3	3.2
'CSH 1'	3.6	4.1	4.7	4.1
'CSH 5'	3.8	4.2	4.6	4.2
'CSH 9'	4.7	5.0	5.0	4.9
Mean	3.5	3.9	4.2	3.9

[a] Grain damage rated visually on a 1–5 scale (mean of data from six seasons).

DF, *F* value, SEM, and LSD for genotypes are 7, 16.49, 0.17, and 0.40, respectively; for infestation levels, the df, *F* value, SEM, and LSD are 14, 69.22, 0.04, and 0.17, respectively; and for genotypes × infestation levels, the df, *F* value, SEM, and LSD are 73, 2.37, 0.20, and 0.43, respectively.

Table 6. Effect of head bug damage on seed germination in eight sorghum genotypes across three levels of infestation under head cage (1984–1987)

Genotype	Seed germination (%) after infestation with			Mean	Noninfested control panicles
	5 pairs	10 pairs	15 pairs		
'IS 2761'	69	54	46	56	94
'IS 9692'	59	56	51	55	96
'IS 17610'	90	90	88	90	99
'IS 17618'	92	95	88	92	98
'IS 17645'	95	89	94	93	98
'CSH 1'	53	48	26	46	94
'CSH 5'	58	56	39	50	95
'CSH 9'	23	16	21	20	95
Mean	67	63	57	62	96

Mean of data from three seasons.

DF, *F* value, SEM, and LSD for genotypes are 7, 4.96, 12.0, and 28.4, respectively; for infestation levels, the df, *F* value, SEM, and LSD are 14, 4.36, 2.4, and 10.3, respectively; and for genotypes × infestation levels, the df, *F* value, SEM, and LSD are 30, 13.19, 0.7, and 28.3, respectively.

infestation levels (Table 5). Up to 84% loss in grain mass was recorded in the susceptible controls 'CSH 1', 'CSH 5', and 'CSH 9'. 'IS 2761' and 'IS 9692' were not significantly different from the susceptible controls. Loss in grain mass was significantly greater ($P < 0.05$) in panicles infested with 15 pairs per panicle compared with those infested with five pairs per panicle. Among the susceptible controls, maximum loss in grain mass was recorded in 'CSH 9', followed by 'CSH 5' and 'CSH 1'.

Seed Germination. Seed germination was greater (88–95%) in 'IS 17610', 'IS 17618', and 'IS 17645' than in the susceptible controls 'CSH 1', 'CSH 5', and 'CSH 9' (16–50% germination) (Table 6). 'IS 2761' and 'IS 9692' had poor germination. Differences in seed germination were not significant across infestation levels. The greatest loss in seed germination was in 'CSH 9'. There were no significant differences among the genotypes in seed germi-

Table 5. Loss in grain mass (%) in eight sorghum genotypes across three levels of infestation with *Calocoris angustatus* under head cage (ICRISAT Center, 1984–1987)

Genotype	Loss in grain weight[a] (%) after infestation with			Mean
	5 pairs	10 pairs	15 pairs	
'IS 2761'	40	72	67	60
'IS 9692'	58	67	68	64
'IS 17610'	23	32	30	28
'IS 17618'	38	30	40	36
'IS 17645'	37	34	31	34
'CSH 1'	58	62	77	66
'CSH 5'	59	69	77	67
'CSH 9'	57	70	84	70
Mean	46	55	58	53

[a] Loss in grain mass in comparison to the noninfested panicles (mean of data from four seasons).

DF, *F* value, SEM, and LSD for genotypes are 7, 4.73, 7.90, and 18.6, respectively; for infestation levels, the df, *F* value, SEM, and LSD are 14, 9.06, 2.06, and 9.0, respectively; and for genotypes × infestation levels, the df, *F* value, SEM, and LSD are 43, 1.66, 9.25, and 19.9, respectively.

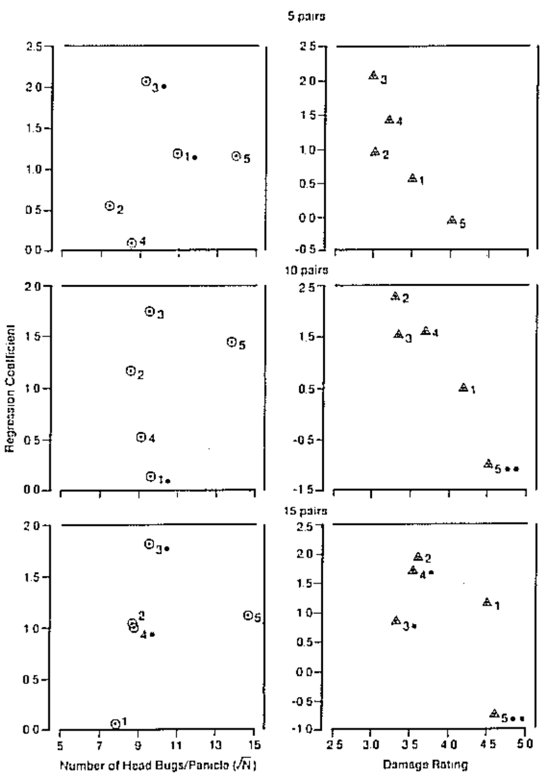

Fig. 1. Stability of performance of five genotypes for resistance to *C. angustatus* (population increase and grain damage) over six seasons at three infestation levels (1, 'IS 9692'; 2, 'IS 17610'; 3, 'IS 17618'; 4, 'IS 17645'; and 5, 'CSH 9'). (*, ** indicate Regression coefficient significant at $P < 0.05$ and $P < 0.01$, respectively.)

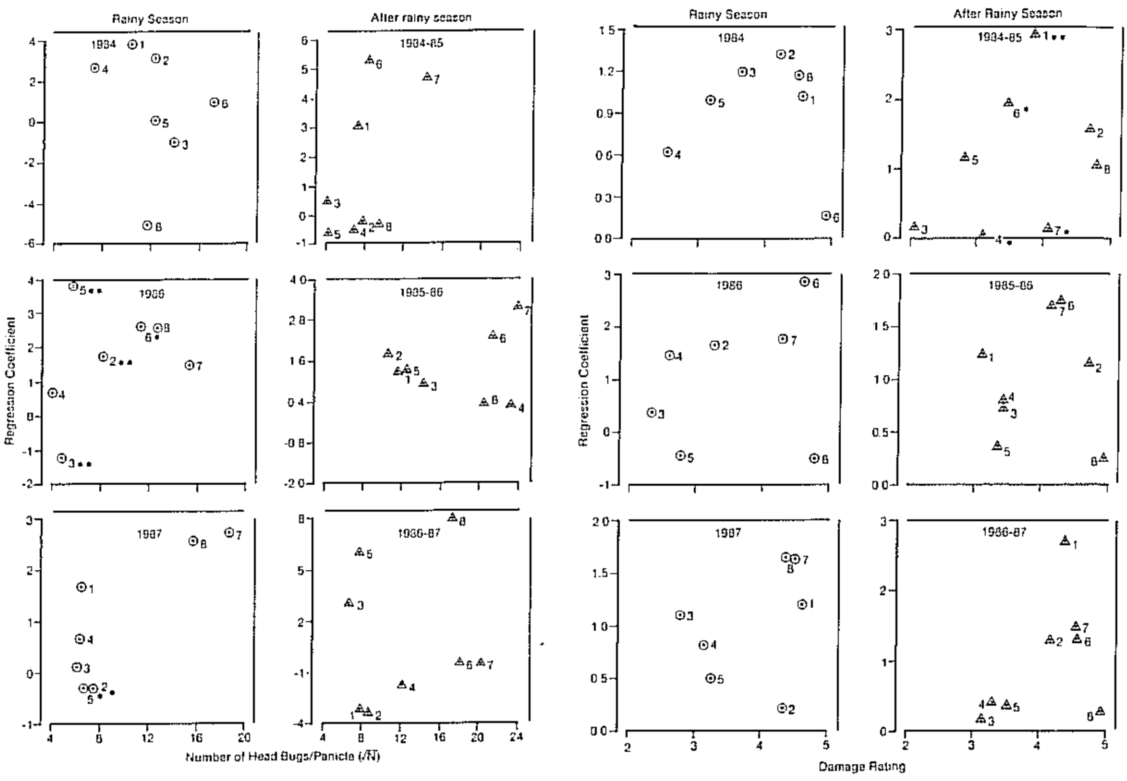

Fig. 2. Stability of performance of eight genotypes for resistance to *C. angustatus* based on population increase (A) and grain damage (B) over three infestation levels in six seasons (1, 'IS 2761'; 2, 'IS 9692'; 3, 'IS 17610'; 4, 'IS 17618'; 5, 'IS 17645'; 6, 'CSH 1'; 7, 'CSH 5'; and 8, 'CSH 9'). (*, ** indicate Regression coefficient significant at $P < 0.05$ and $P < 0.01$, respectively.)

nation in the noninfested controls (94–99% germination).

Extent of grain damage was positively correlated with the bug population increase ($r = 0.43$ to 0.81; significant at $P < 0.05$ and $P < 0.01$, respectively). Loss in grain mass ($r = 0.03$ to 0.82; $P =$ ns and $P < 0.01$, respectively), and seed germination ($r = -0.31$ to -0.77; $P =$ ns and $P < 0.01$, respectively) were highly influenced by the bug numbers. Visual damage rating was correlated with loss in grain mass ($r = 0.64$ to 0.82; $P < 0.05$ and $P < 0.01$, respectively). Germination was negatively associated with loss in grain mass ($r = -0.66$ to -0.81; $P < 0.05$ and $P < 0.01$, respectively) and visual damage rating ($r = -0.68$ to -0.91; $P < 0.05$ and $P < 0.01$, respectively). Greater numbers of bugs resulted in more damage to the grain (greater damage rating) which decreased the grain mass and seed germination.

Stability of Resistance. Regression coefficients computed by the method of Eberhart and Russell (1966) were taken as a measure of the relation of bug population increase to changes in the environment; i.e., climatic factors which may favor population increase. Therefore, genotypes resistant to the bugs and stable under a wide range of environments would have b values (regression coefficients) equal or close to zero, with a low population increase ($\sqrt{N} < 10$) irrespective of the changes in environment. The regression values from Eberhart and Russell's analysis are plotted against mean bug numbers to give an idea of the genotypic stability (Fig. 1 and 2). 'IS 17610' and 'IS 17645' had lower population increase ($\sqrt{N} \leq 10$) under head cages over seasons at a particular level of infestation, and their regression coefficients were ≤ 1 (Fig. 1). The regression coefficient of 'IS 17645' was significant at 15 pairs per panicle; i.e., its resistance was unstable over seasons at higher levels of infestation. The susceptible check 'CSH 9' had greater population increase ($\sqrt{N} > 15$) over seasons and infestation levels, and its b values were >1, indicating that this genotype will support greater numbers of bugs under favorable environmental conditions. 'IS 9692' and 'IS 17618' either had b values >1, or the b values were significant. Thus, these genotypes are unstable in their resistance to bugs over seasons, across infestation levels, or both.

Based on grain damage ratings, 'IS 9692' and 'IS 17610' were stable over seasons at five pairs per panicle. However, none of the genotypes were stable in their reactions to bug damage at higher levels of infestation (10 and 15 pairs per panicle). Thus, the extent of grain damage is highly influenced by the prevailing environmental conditions. The susceptible check suffered maximum bug damage over seasons.

Genotypic reactions across infestation levels (within a season) were unstable. Regression coefficients of 'IS 9692', 'IS 17610', 'IS 17618', and 'IS 17645' were ≤ 1 in at least three seasons. However, their regression coefficients were significant ($P <$ 0.05) in some seasons. Genotypic performance was more stable after the rainy season than during the rainy season. Thus, genotypic response to different levels of infestation was influenced by the environmental conditions.

Grain damage was lower (damage rating <3.5) across infestation levels in 'IS 17610', 'IS 17618', and 'IS 17645' during the 1984 rainy season. Regression coefficients of these genotypes were not significantly ($P < 0.05$) greater than unity (except 'IS 17618' during 1984–1985 after the rainy season).

Identification of stable sources of resistance to insects is an important component of an insect resistance breeding program. Not only do the sources need to be stable across infestation levels but they also have to be consistent across environments. Host-plant resistance to insects (e.g., sorghum midge) is strongly influenced by the environment (Faris et al. 1979, Sharma et al. 1988). The head cage technique can be used to test entries against a range of insect densities to know their level of resistance. However, genotypes showing stable resistance across a range of insect densities, or prevalent and possible levels of infestation under field conditions, should also be tested across seasons. For this, regression coefficients and the deviations from regression of a genotype on the environmental index can serve as useful parameters to identify lines that would support lower insect numbers, suffer less damage across environments, or both.

Cultivar nonpreference, reduced oviposition, and antibiosis are the major components of resistance to *C. angustatus* (Sharma & Lopez 1990). Morphological characteristics of panicle, glumes, and grain, and secondary plant substances influence the genotypic susceptibility to these bugs (Sharma 1985). Environmental changes within and across seasons influence genotypic resistance to insects (Faris et al. 1979, Sharma 1985, Sharma et al. 1988). Environmental conditions not only affect the survival and development of these bugs, but also influence morphological characteristics and chemical composition of the plants, which may in turn affect the genotypic resistance or susceptibility to *C. angustatus*.

Among the commercial sorghum hybrids, insect population increase was greatest on 'CSH 5', followed by 'CSH 1' and 'CSH 9'. However, 'CSH 9' suffered significantly higher grain damage in terms of damage rating and percentage loss in grain mass. These differences may be partly attributed to panicle compactness ('CSH 9' has a compact panicle and 'CSH 1' a semicompact panicle), grain size ('CSH 1'—large and 'CSH 5'—small), and panicle size. The rate of grain development in the initial phase may also influence the extent of grain damage. Similarly, seed germination was significantly lower in 'CSH 9' compared with 'CSH 1' and 'CSH 5'.

Analysis of stability of resistance across seasons indicated that 'IS 17610' was the most stable genotype (Fig. 1). Grain damage was significantly less in 'IS 17610', 'IS 17618', and 'IS 17645' as compared with the commercial cultivars 'CSH 1', 'CSH 5', and 'CSH 9'. These cultivars also had significantly higher seed germination across seasons than the susceptible controls. 'IS 2761' and 'IS 9692' generally had lower population increase, but suffered higher grain damage and showed poor seed germination in two or more seasons. Thus, these cultivars were not stable for their reaction to *C. angustatus* across the traits measured. Therefore, bug resistance in sorghum needs to be evaluated against a range of parameters such as population increase, loss in grain mass, and seed germination across infestation levels and seasons.

'IS 17610' and 'IS 17645', which show lower bug population increase and less grain damage, can be used in breeding for resistance to head bugs. These lines are tall and belong to *guinense* landraces. They need to be converted into improved agronomic plant types. Other *C. angustatus*-resistant lines such as 'IS 2761' (showing nonpreference to *Calocoris*) and 'Malisor 84-7' and 'CSM 388' (resistant to *Eurystylus immaculatus* Odhiambo) (unpublished data) should also be involved in the breeding program to diversify and increase the level of resistance.

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