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Response of Sorghum Cultivars and Near Isogenic Lines to Head Bug (*Eurystylus oldi* Poppius) Damage

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Abstract: Five commercial sorghum cultivars, three isogenic lines and two internationally known head bug resistant cultivars as checked, were evaluated for two seasons to determine their performance under head bug (*Eurystylus oldi* Poppius) infestation using four evaluation methods to classify the cultivars. The experiment was split-plot with three replications, infestation (control and artificial) and cultivars constituted main and sub-plot treatment respectively. Seasons of evaluation was not significant, infestation, cultivars and their interaction was highly significant ($p \leq 0.01$) for grain damage rating, germination percentage panicle length and weight, 1000 grain weight and grain yield, therefore genetic variation in resistance to head bug was present. HRBC 017 had the least percent reduction (2%) for 1000 grain weight and Samsorg 40 had the higher percent reduction (55%) for grain yield. HRBC 017 was the least susceptible while Samsorg 40 was the most susceptible. Yield reduction index gave similar trend. Insect resistant index identified HRBC 017 as the most resistant, while Samsorg 3 the least resistant. The four evaluation methods classified the genotypes: HRBC 017, HRBC 013 and HRBC 029 as resistant, Samsorg 17 and Samsorg 18 as tolerant, while Samsorg 3, Samsorg 17 and Samsorg 40 as susceptible.

Key words: Percent reduction, susceptibility, yield reduction, insect resistance indices, *E. oldi, Sorghum bicolor*

Introduction

Sorghum (*Sorghum bicolor* L.) is an important food crop and agro-allied raw material in sub-Saharan Africa. The current sorghum production of 6.10 million tones on 5.70 million hectares is expected to double in the next decade (FAO, 1987; ICRISAT and FAO, 1996). However, this projected production may not be achievable, due to several factors militating against sorghum production. Currently insect pests are the major factors limiting sorghum production in West and Central Africa (Nwanze, 1985; Ajayi and Tabo, 1995).

Presently head bugs (*Eurystylus* spp., *Compylomma* spp., *Creaontiades* spp. and *Taylorilygus* spp.) are pests of economic importance on sorghum particularly *Eurystylus oldi* (Poppius). *E. oldi* spoils grain quality and quantity and increase incidence of grain mould. Yield losses of between 30 and 90% have been attributed to *E. oldi* damage in the Nigerian Savanna (Ajayi and Tabo, 1995; Ajayi, 1996).

In other to minimize the high yield losses attributed to *E. oldi* damage in sorghum the Institute for Agricultural Research, Samaru, Nigeria had initiated a breeding programme to produce resistant/tolerant lines that will be long lasting, environmentally safe and affordable. Various breeding methods had been used to obtain resistant/tolerant genotypes by researchers: Sharma *et al.* (1995), Ratnadass and Ajayi (1995), Showemimo (1998 and 2001). The objective of this study was to evaluate the response of commercial sorghum cultivars and near isogenic lines under artificial and non-artificial *E. oldi* infestation using four screening/evaluation methods.

Materials and Methods

The plant materials are five officially released sorghum cultivars (Samsorg 3, 14, 17, 18 and 40), three near isogenic lines; HRBC 013, 017 and 029 (generated by repeated backcrossing to resistant parents, while desire *E. oldi* resistance traits at each round of crossing are selected for) and two internationally known resistant cultivars (Malisorg 84-7 and IS 17610) as check, were evaluated for two seasons (1998 and 1999) under control and artificial *E. oldi* infestation.

The experimental layout was split-plot, the *E. oldi* infestation (C = control and AI = artificial infestation) was the main-plot, while the cultivars was sub-plot. The main-plot treatments were arranged in a Randomized Complete Block Design with three replications. Each sub-plot size was 2 rows each, 5 m long, 0.75×0.25 m inter and intra row spacing, respectively. Five seeds were planted and later thinned to two plants per stand two weeks after planting. Single superphosphate was applied at 32 kg ha^{-1} during land preparation, split nitrogen fertilizer (Urea) was applied at 32 kg ha^{-1} as basal and 30 kg ha^{-1} as top dressing. All other IAR recommended cultural and crop management practices were adhered to raise a successful crop (IAR, 1993). At half anthesis, 10 pairs of adult *E. oldi* was introduced into each head cage (Sharma *et al.,* 1992), while the control was caged without *E. oldi* infestation.

Data was recorded for grain damage rating (1 = lest damaged to 9 = highly damaged), germination percentage, panicle length (cm), panicle weight (kg), 1000 grain weight (g) and grain yield (t ha^{-1}). All measurements were subjected to analysis of variance (separately and combined) by statistical Analysis System (SAS, 1985). Mean separation was done using Duncan's New Multiple Range Text (Obi, 1986). Cultivar performance was evaluated for percent reduction; (% Red=[(C-AI)/C]×100) susceptibility index (% injury) by the following formula: % injury = C-AI/AI x 100, (Blum, 1988) where, C and AI are cultivar's mean yield or trait values of control and artificial infestation respectively; yield reduction index (YRI) = $[1-(Y_{AI} / Y_C)]$ x 100 as used by Araghi and Assad (1998); where, Y_{AI} and Y_C are mean yield values of artificial infestation and control, respectively and Insect Resistance Index (IRI) $[X-(C_1+C_2)/2] / [1+(C_1 x C_2)/2]$ x 100 according to Reddy *et al*., (1997), where, X, C_1 and C_2 are cultivar mean value of trait (in this case yield) under infestation and mean value of the same trait for first and second check under infestation, respectively.

Results and Discussion

The mean squares estimates (Table 1) show that seasons (years) of evaluation was not significant for all the traits studied. Infection (control and infested) was highly significant for all the traits except grain damage rating that was significant at $p \leq 0.05$. Cultivars and infection x cultivars were highly significant for all the traits studied thus, differential cultivars response to head bug infestation. Mean data of the cultivars across the two seasons are, therefore, presented.

Percent reduction in panicle length due to head bug feeding activity ranged between 4% for HRBC 017 (an isogenic line), malisor 84-7 and IS 17610 (resistant checks) and 29% for Samsorg 40. The remaining isogenic lines had less than 10% panicle length reduction, while the commercial cultivars panicle length were reduced by more than 10%. Similar trend was obtained for the remaining two yield

Table 1: Mean square estimates of sorghum cultivars and head bug infestation for 6 agronomic traits

Source of variation	df	Mean squares: Grain damage rating	Germination percentage	Panicle length	Panicle weight	1000 grain weight	Grain yield
Blocks	2	0.25	1.64	6.41	0.0125	2.51	2330.49
Years	1	0.74	3.51	8.06	0.0291	27.32	1861.24
Infections	1	31.6*	691.55**	56.53**	0.3998**	226.41**	8724.71**
Error (a)	2	1.19	7.04	0.49	0.0025	2.19	68.17
Cultivars	9	86.07**	907.22**	74.31**	0.6917**	388.1**	11465.33**
Infection x cultivar	9	71.69**	720.11**	58.44**	0.4685**	129.73**	9087.26**
Error (b)	36	21.41	189.76	17.32	0.1288	30.09	2018.92

*,** Significance at $p \leq 0.05$ and 0.01, respectively.

Table 2: Cultivar means estimated for yield and yield components averaged 2 years under control and artificial head bug infestation

	Panicle length (cm)			Panicle weight (kg)			1000 grain wt (g)			Grain yield (t ha^{-1})		
Cultivar	C	AI	%Red	C	AI	%Red	C	AI	%Red	C	AI	%Red
Samsorg 3	20g	16de	20	0.531g	0.399g	25	20.3c	16.1d	21	1.0ef	0.7f	30
Samsorg 14	18h	16de	11	0.441h	0.365g	17	18.0d	15.7d	13	1.1e	0.9e	20
Samsorg 17	18h	15e	17	0.473h	0.378g	20	20.2c	16.0b	18	1.3e	0.9e	31
Samsorg 18	21f	18d	14	0.623f	0.510e	18	19.3cd	15.2de	21	1.6d	1.3d	18
Samsorg 40	24c	17d	29	0.675e	0.469f	31	22.7b	17.bd	22	2.0c	0.9e	55
HRBC013	22e	20c	9	1.889d	1.754d	7	21.2bc	19.2bc	9	2.0c	1.8c	10
HRBC017	25b	24a	4	2.377a	2.167a	5	25.1a	24.6a	2	2.3a	2.1a	8
HRBC029	23d	21c	9	1.920d	1.770d	8	23.5b	21.4b	9	2.0c	1.8c	10
Malisor84-7	24c	23ab	4	2.043c	1.899c	7	22.3b	20.5b	8	2.0c	1.8c	10
IS17610	26a	25a	4	2.246b	2.095b	7	23.3b	21.9b	6	2.1b	1.9b	9
Mean	22.1	19.5	12.1	1.322	1.181	14.5	21.6	18.9	12.9	1.7	1.4	20.1

Means with the same letters in a column are not significant different (DNMRT at $p \leq 0.01$).

components (Panicle weight and 1000 grain weight), where HRBC 017 had the least percent reduction less than the two resistant checks. Percent reduction in grain yield was between 8 and 55%. HRBC 017; HRBC 013 and HRBC 029 had the least percent reduction of 8, 10 and 10%, while Samsorg 40, Samsorg 17 and Samsorg 3 (55, 31 and 30, respectively) had the highest grain reduction due to head by infestation (Table 2). Similar variability in sorghum populations subjected to head bug infestation had been reported by Ratnadass *et al.* (1995), Sharma *et al.* (1992), Ajayi (1996) and Showemimo *et al.* (2001).

The susceptibility index revealed that Samsorg 40, 17 and 3 are the most susceptible thus ranked the highest percent injured (8th, 7th and 6th), three isogenic lines HRBC 017, HRBC 013 and HRBC 029 are the least susceptible apart from the resistant check (Table 3). The cultivar grain yield reduction index followed the same trend as that of susceptibility index. The insect resistant index classified the cultivars; HRBC 017 and IS 17610 are distinctly resistant, HRBC 013, HRBC 029 and Malisor 84-7 had similar level of resistance to head bug damage, the remaining five sorghum cultivars are highly suscuceptible similar method had been used by Reddy *et al.* (1997) to classify sorghum under insect infestation. The average performance index of the cultivars measures the overall cultivar performance across the three evolution methods using their rank. Apart form the two resistant checks, incidentally the parents of which the isogenic lines were developed HRBC 017 was outstanding with high level of head bug resistance (API = 1.0); followed by HRBC 013 and HRBC 029 that posses some levels of resistance (API = 1.0 each) Samsorg 14 and Samsorg 18 tolerant are to head bug infestation AP = 4.3 and 4.7), Samsorg 3, Samsorg 17 and Samsorg 40 are susceptible to head bug infestation. These results

Table 3: Susceptibility (%injury), Yield Reduction (YRI), Insect Resistance (IRI) indices and Average Performance Index (API) of 10 sorghum cultivars across 2 years

Cultivar	%Injury	YRI (%)	IRI (%)	API
Samsorg 3	42.9 (6)	30.0 (6)	- 40.4 (6)	6.0
Samsorg 14	22.2 (4)	18.2 (4)	- 35.1 (5)	4.3
Samsorg 17	44.4 (7)	30.8 (7)	- 35.1 (5)	6.3
Samsorg 18	23.1 (5)	18.8 (5)	- 20.3 (4)	4.7
Samsorg 40	122.2 (8)	55.0 (8)	- 35.1 (5)	7.0
HRBC 013	11.1 (3)	10.0 (3)	- 1.8 (3)	3.0
HRBC 017	9.5 (1)	8.7 (1)	9.2 (1)	1.0
HRBC 029	11.1 (3)	10.0 (3)	- 1.8 (3)	3.0
Malisor 84-7	11.1 (3)	10.0 (3)	- 1.8 (3)	3.0
IS17610	10.5 (2)	9.5 (2)	1.8 (2)	2.0

Rank in parenthesis based on each evaluation method. API: Indicate average cultivar's rank across the 3 evaluation methods

are similar to those obtained by Ajala (1992) on maize, Olonju-Dixon *et al.* (1990) on sorghum and Panda and Heinrichs (1983) on rice using any of the three evaluation methods for classifying insect resistant crops.

Conclusions

Based on the results obtained, the cultivars and near isogenic lines performed differentially under control and artificial head bug infestation, thus, potentials for crop improvement. The four evaluation methods were able to classify the cultivars and isogenic lines; isogenic line HRBC 017. HRBC 013 and HRBC 029 are resistant to head bug, the commercial cultivars; Samsorg 14 and Samsorg 18 are tolerant while Samsorg 3, Samsorg 17 and Samsorg 40 are susceptible to head bug. The resistant and tolerant cultivars are recommended for use in desired agro-ecological zone and or for further crop improvement and subsequent release to farmers.

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