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Damage and Control of Panicle Insect Pests of Sorghum (Sorghum Bicolor (L) Moench) In the North Eastern Nigeria

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ABSTRACT

Damage and control of panicle insect pests was studied on eight sorghum varieties/cultivars in field trials conducted at Yola and Kaltungo in 2011 cropping season in the North Eastern Nigeria. The experiment was laid out in a Split-Plot Design (SPD) replicated three times on $12m^2$ plots. The eight sorghum varieties/cultivars were the sub-plot, while treated with carbofuran; protected with muslin cloth and untreated were the main plots. Five damage parameters were taken into account at sorghum maturity: discoloration and punctures; moldiness; germination test; floaters and grain yield. SAMSORG-17 had the highest grain discoloration and punctures (7.3) and Ex-Tula Red cultivar was the least (4.17). Moldiness was high on Tiksha-Mamza (Ex-Garkida) (10.50) and least on Ex-Tula Red cultivar (3.50). Ex-Tula Farafara cultivar had the highest percentage germination (92.82%) and SAMSORG-41 had the lowest (78.67%). Percentage floaters were highest on Tiksha-Mamza (Ex-Garkida) (9.83%) with lowest on Ex-Tula Farafara cultivar (1.33%). When carbofuran was applied there was no significant difference between the treatments in number of leaves and plant height in both locations. In grain yield, the treated plots yielded 2,669.93 $kgha^{-1}$ at Yola and Kaltungo 1740.68 $kgha^{-1}$. The natural infested plots yield was 1988.25 $kgha^{-1}$ at Yola and Kaltungo 1574.88 $kgha^{-1}$. The percentage yield loss for the treated plots with carbofuran at Yola, Ex-Tula Farafara cultivar had the highest(43.24%) and SAMSORG-41 was the least (4.12%) compared with protected with cages. The use of carbofuran applied in the whorls of sorghum gave more grain yield than the protected and the untreated plots. Therefore, carbofuran remains a good and effective insecticide against panicle insect pests of sorghum.

Keywords: *Discolouration, Panicle Pests, Moldiness, Floaters, Damage, Grain Yield*

1. INTRODUCTION

Panicle insect pests are the most important in pests of sorghum; this is because the grains of sorghum are the principal and the most important part of the crop [10, 13 and 14]. In West Africa, panicle feeding insects account for up to 86% yield loss in sorghum [8 and 10]. In a series of collections from Nigeria, Niger, Mali and Burkina Faso, panicle insect pests were found to be the prominent pests in West African region [4, 9, 10 and 15]. Taylor [22] further stated that, the major problem of sorghum is the panicle insect pests which result to a large yield loss notably the headbugs. The panicle insect pests that damage sorghum include such families as Mirdae, Lygaeidae, Pyrrhocoridae, Pentatomidae, Coreidae, Rhopalidae, Anthocoridae and some unidentified species.

Grain damage by panicle insect pests is an important limiting factor for increasing sorghum production through newly improved high yielding cultivars [10, 16 and 19]. The damage of panicle insect pests on sorghum plant is not the same all over its area of occurrence. The presence of panicle insect pests in West Africa has been on the increase specifically headbugs, and its increasing population in recent years constitutes a serious problem to sorghum production [4, 5, 6, 10, 12 and 13). The exact yield losses caused by panicle insect pests have not been quantified especially in West Africa, but losses vary from 5.8-84% [1, 10 and 21].

Most work done on panicle insect pests were based on their occurrence, biology, distribution, damage and interaction with grain mould [13, 14, 15 and 20], but their damage and control have not been published [13]. This paper, reports on their damage and control on different sorghum varieties/cultivars.

2. MATERIALS AND METHODS

Trials were established at the Teaching and Research farm of the Department of Crop protection, Modibbo Adama University of Technology Yola in Adamawa state and Kaltungo in Gombe State which are in Guinea savanna zone of Nigeria during 2011 cropping season. Yola is located within latitude 9^o 11′ N to 9^o 19′ N and longitude 12^o 20′ E to 12^o 31′ E [23]. While Kaltungo is located within the latitude 9^o 48′ N to 9^o 51′ N and longitude 11^o 18′ E to 11^o 32′ E [24].

2.1 Sorghum Varieties and Experimental Design

Five varieties of sorghum were obtained from IAR, Samaru Zaria and three cultivars were locally sourced. These varieties/cultivars were:

- SAMSORG-41: Medium height (1.5 m) with compact panicle matures 95-100 days after emergence.
- SAM SORG-14: Tall-improved local variety (3-4 m) with loose panicle matures 130-140 days after emergence.
- SAMSORG-17: Medium height (1.5 m) with compact panicle matures 165-175 days after emergence.
- SAMSORG-37: Short height (1.2 m) with semi-compact panicle, matures 95-105 days after emergence.

SAMSORG-39: Short height (1.2 m) with semi-compact panicle, matures 95-105 days after emergence.

Tiksha-Mamza (Ex-Garkida): Short local cultivar with compact panicle, matures 95-100 days after emergence.

Ex-Tula Red cultivar: Tall local cultivar (3.5-5 m) with loose panicle, matures 165-175 days after emergence.

Ex-Tula Farafara cultivar: Tall local cultivar (3.5-5 m) with pendulous to lose panicle, white seeds, matures 165-175 days after emergence.

The experiment was laid out in a Split-Plot Design (SPD) replicated three times with eight varieties/cultivars of sorghum as treatment. Each replication was separated by 1 m apart and inter plot spacing was 0.5 m. the plot size was 3 x 4 m^2 (12 m^2).

2.2 Cultural Practices

The selected fields were ploughed with a tractor and the fields were later designed according to the experimental design. Apron star 50 DS (metal-axyl 10%, carboxin 6% + furathiocarb 34%) at the rate of 1 sachet per 10 kg of seed was used to dress the seeds before planting. The seeds were sown on 24th June at Yola and 28th June at Kaltungo in 2011 for effective data collection. The seeds were sown at the rate of 4-6 per hole in a depth of 2cm. The intra-row spacing was 40 cm, while the inter row spacing was 75 cm. The plants were thinned to 2 plants per stand at two weeks after emergence. Split application of fertilizer NPK 15:15:15 were applied at four and eight weeks after emergence at the rate of 64 kg N ha^{-1}. Manual hoe weeding was carried out two times depending on the weed infestation and followed by molding-up of earth around sorghum stands in order to prevent lodging of the sorghum plants..

2.3 Experimental Procedure and Data Analysis

Damage rating assessment was determined in the laboratory using the following parameters:

a. Grain Damage Rating

Discolouration and punctures due to insect feeding and oviposition was examined by hand threshing, 50 grains per replicate and varieties/cultivars were observed under a compound microscope and ranked on a scale of 1-5 [9 and 20].

i. No discoloration
ii. Seeds with few feeding punctures
iii. Seeds slightly discolored with <25% feeding punctures of grain surface and slightly shriveled.
iv. > 25% but less than 50% grain discolored, moderately shriveled and few feeding punctures.
v. > 50% of grain discolored, severely shriveled and a lot of feeding punctures

b. Grain Moldiness

Fifty grains from each replicate and varieties/cultivars were examined under a compound microscope and rated on a scale of 1-5.

1. No mould
2. ($\frac{1}{4}$) 25% of the surface with mould.
3. ($\frac{1}{2}$) 50% of the surface with mould.
4. ($\frac{3}{4}$) (5% of the surface with mould.
5. The entire surface with mould.

c. Grain Mass and Floaters

A sample of 100 grains was chosen at random from each replicate and submerged in a beaker containing a sodium nitrate ($NaNO_3$) of specified gravity 1.24. The number of grains floating was counted and expressed in a percentage of the total number of the grain.

d. Germination Test

A sample of 100 grains was randomly chosen from each replicate and varieties/cultivars which was placed on water soaked filter paper in a Petri dish and covered and kept at a room temperature (35^0C) for 72 hours. The percentage of the grain with radicle and plumule emergence was recorded [9, 14 and 19].

e. Application of Carbofuran

Carbofuran (carbamic acid, methyl-2,3-dimethyl-7-benzofuranyl ester) 3 G at the rate of 0.56 kg a.i ha^{-1} was used for the treated plots for the eight varieties/cultivars in two split doses at 4 and 8 weeks after emergence. The application of carbofuran was done in the whorls of sorghum in order to prevent environmental pollution through spillage by running into water ways. The aim was to control infestation by insect pests systematically. At harvest, 5 panicles per plot were chosen from the natural infested plots that were similar in size with the treated plot. The panicles were hand threshed and percentage (%) yield loss was determined using the formula;

$$\text{Yield loss (\%)} = \frac{A-a}{A} X \frac{100}{1}$$

Where:
A = weight of treated panicles with carbofuran
a = natural infested panicles.

The data collected were subjected to analysis of variance (ANOVA) using SAS [18] Software Version 8(2), means were separated Student-Newman-Keuls (SNK) test for variables (p=0.05).

3. RESULTS

The damage inflicted by panicle insect pests due to their feeding and oviposition, for the two locations (Yola and Kaltungo) are presented in Table 1-3.At Yola, SAMSORG-37 and Tiksha-Mamza (Ex-Garkida) had the highest level of discoloration and punctures (6.33 each) and Ex-Tula Farafara cultivar had the lowest discoloration and puncture of 3.67 (Table 1 and Plate 1-3). At Kaltungo, SAMSORG-17 had the highest level of discoloration and puncture (8.67) and lowest was found on Ex-Tula Red cultivar with 4.33 (Table 2 and Plate 1-3). The highest rate of moldiness was noticed on Tiksha-Mamza (10.67) while the least was Ex-Tula red cultivar (3.67) at Yola. At Kaltungo, Tiksha-Mamza had (10.33) and Ex-Tula red cultivar had the least (4.33). The germination percentage at Yola was high on Ex-Tula Farafara cultivar (92.33%) with lowest on SAMSORG-41 (79.00%). At Kaltungo, Ex-Tula Farafara cultivar had the highest germination (93.33%) and SAMSORG-41 was the least (78.33%). At Yola and Kaltungo there were more floaters on Tiksha-Mamza (Ex-Garkida) 10.00 and 9.67 % respectively. The least floaters was on Ex-Tula Farafara cultivar at Yola and SAMSORG-14 at Kaltungo which was (1.33 each). SAMSORG-37 had the highest grain yield at Yola (3,082.4 $kgha^{-1}$) and SAMSORG 14 had the highest in Kalungo (2,563.3 $kgha^{-1}$). Gran yield was lowest on Ex-Tula red cultivar and Ex-Tula Farafara cultivar at Yola and Kaltungo were 1,891.0 $kgha^{-1}$ and 1,216.6 $kgha^{-1}$ respectively (Table 1 and 2).

In a combined analysis SAMSORG-17 had the highest discoloration and feeding punctures (7.3) and Ex-Tula red cultivar had the least (4.17). Moldiness was high on Tiksha-Mamza (Ex-Garkida) (10.50) and least on Ex-Tula red cultivar (3.50). Ex-Tula Farafara cultivar leads in percentage germination (92.82%) and SAMSORG-41 had the lowest (78.67%). Percentage floaters was high on Tiksha-Mamza (Ex-Garkida) (9.83%) with lowest in Ex-Tula Farafara cultivar (1.33%). SAMSORG-37 had the highest grain yield of 2,638.87 $kgha^{-1}$ and Ex-Tula Farafara cultivar recorded the least 1,800.84 $kgha^{-1}$ (Table 3).

When carbofuran was applied there was no significant difference between the treatments in number of leaves and plant height in both locations. The grain yield per hectare on the treated plots yielded highest; 2,669.93 $kgha^{-1}$ at Yola and Kaltungo 1740.68 $kgha^{-1}$. The natural infested plots yield was 1988.25 $kgha^{-1}$ at Yola and Kaltungo 1574.88 $kgha^{-1}$ (Table 4). The percentage yield loss on treated plots with carbofuran and the use of head cage technique for protection at Yola, the result showed that Ex-Tula Farafara cultivar had the highest percentage yield loss with 43.24% and SAMSORG-41 was the least (4.12%) and the treated plots (Figure 1). At Kaltungo, Tiksha-Mamaza (Ex-Garkida) had the highest yield loss (49.32%) and SAMSORG-17 with (10.04%) was the lowest (Fig. 2). When protected was compared with the natural infested grains, the percentage (%) reduction in grain yield was high on Ex-Tula Farafara cultivar (37.00%) and lowest on SAMSORG-41 with (0.69%) at Yola and at Kaltungo the highest was SAMSORG-14 (25.31%) and lowest on SAMSORG-39 (4.75%) Figures 1 and 2 respectively. In a combined analysis, it was Ex-Tula farafara cultivar that had the highest percentage (%) reduction in grain yield (41.40%) and SAMSORG-41 was the lowest (16.82%) in treated plots. In protected plots, Ex-Tula farafara cultivar had the highest (25.78%) and low on SAMSORG-17 with 3.98% (Figure 3).

Table 1: Insect Damage Parameters on Eight Sorghum Varieties at Yola in 2011 Cropping Season

Varieties	Number of Leaves	Avearge Plant Height	Discolouration and Puncture	Mouldiness	Germination Test (%)	Floaters (%)	Grain Yield (Kg/ha)
SAMSORG-41	9.22 ^{c}	1.54 ^{e}	5.00 ^{ab}	5.67 ^{bc}	79.00 ^{b}	1.67 ^{b}	2856.6 ^{a}
SAMSORG-14	10.89 ^{ab}	3.32 ^{c}	5.33 ^{b}	6.67 ^{b}	90.00 ^{a}	1.67 ^{b}	1948.3 ^{c}
SAMSORG-17	11.33 ^{a}	1.70 ^{d}	6.00 ^{a}	9.67 ^{a}	90.67 ^{a}	2.67 ^{b}	2168.1 ^{bc}
SAMSORG-37	10.11 ^{b}	1.41 ^{f}	6.33 ^{a}	6.33 ^{b}	88.67 ^{a}	2.67 ^{b}	3082.4 ^{a}
SAMSORG-39	10.67 ^{ab}	1.28 ^{g}	5.67 ^{ab}	7.00 ^{b}	87.00 ^{a}	3.33 ^{b}	2411.1 ^{b}
Tiksha-Mamza (Ex-Garkida)	10.56 ^{ab}	1.79 ^{d}	6.33 ^{a}	10.67 ^{a}	85.33 ^{a}	10.00 ^{a}	1982.3 ^{c}
Ex-Tula red cultivar	11.22 ^{a}	4.43 ^{a}	4.00 ^{ab}	3.67 ^{c}	91.33 ^{a}	2.67^{b}	1891.0 ^{c}
Ex-Tula Farafara cultivar	11.56 ^{a}	4.27 ^{b}	3.67 ^{a}	4.00 ^{c}	92.33 ^{a}	1.33 ^{b}	2385.1 ^{b}
Mean	10.69	2.47	5.29	6.71	88.04	3.25	2340.62
CV (%)	6.82	5.40	15.97	15.39	3.71	38.06	12.69
S.E	0.73	0.13	0.89	1.03	3.27	1.24	297.03

Means with the same letter are not significantly different at P = 0.05 using Student-Newman-Kuels (SNK) test for variables

Table 2: Insect pests Damamge Parameters on Eight Sorghum Varieties at Kaltungo in 2011 Cropping Season

Varieties	Number of Leaves	Avearge Plant Height	Discolouration and Puncture	Mouldiness	Germination Test (%)	Floaters (%)	Grain Yield (Kg/ha)
SAMSORG-41	9.67 ^{d}	1.46 ^{d}	5.67 ^{ab}	8.33 ^{ab}	78.33 ^{b}	3.67 ^{b}	2194.9 ^{b}
SAMSORG-14	11.22 ^{bc}	3.28 ^{b}	5.33 ^{ab}	8.67 ^{ab}	88.33 ^{ab}	1.33 ^{b}	2563.3 ^{a}
SAMSORG-17	11.33 ^{bc}	1.69 ^{c}	8.69 ^{a}	10.00 ^{a}	90.67 ^{a}	3.67 ^{b}	1748.5 ^{c}
SAMSORG-37	11.00 ^{bc}	1.36 ^{d}	5.33 ^{ab}	7.33 ^{ab}	83.00 ^{ab}	4.00 ^{b}	2195.3 ^{b}
SAMSORG-39	10.44 ^{c}	1.34 ^{d}	6.00 ^{ab}	5.67 ^{bc}	85.33 ^{ab}	3.00 ^{b}	2081.6 ^{b}
Tiksha-Mamza (Ex-Garkida)	10.89 ^{c}	1.74 ^{c}	8.00 ^{ab}	10.33 ^{a}	82.33 ^{ab}	9.67 ^{a}	1899.5 ^{bc}
Ex-Tula red cultivar	11.78 ^{ab}	4.29 ^{a}	4.33 ^{b}	3.33 ^{c}	93.00 ^{a}	2.33 ^{b}	1974.1 ^{bc}
Ex-Tula Farafara cultivar	12.11 ^{a}	4.23 ^{a}	5.33 ^{ab}	3.33 ^{c}	93.33 ^{a}	1.33 ^{b}	1216.6 ^{d}
Mean	11.06	2.42	6.08	7.13	86.79	3.63	1984.2
CV (%)	6.05	5.81	24.43	18.15	4.75	42.35	12.42
S.E	0.67	0.14	1.49	1.29	4.12	1.54	246.36

Means with the same letter are not significantly different at P = 0.05 using Student-Newman-Kuels (SNK) test for variables

Table 3: Insect Pests Damage Parameters on Eight Sorghum Varieties of Two Locations in 2011 Cropping Season (Combined Analysis)

Varieties	Number of Leaves	Avearge Plant Height	Discolouration and Puncture	Mouldiness	Germination Test (%)	Floaters (%)	Grain Yield (Kg/ha)
SAMSORG-41	9.44 ^{d}	1.50 ^{e}	5.33 ^{ab}	7.00 ^{b}	78.67 ^{d}	2.67 ^{b}	2525.76 ^{a}
SAMSORG-14	11.06 ^{bc}	3.30 ^{c}	5.33 ^{ab}	7.67 ^{b}	89.17 ^{abc}	1.50 ^{b}	2255.80 ^{b}
SAMSORG-17	11.33 ^{ab}	1.69 ^{d}	7.33 ^{a}	9.83 ^{a}	90.67 ^{ab}	3.17 ^{b}	1958.26 ^{c}
SAMSORG-37	10.56 ^{c}	1.38 ^{f}	5.83 ^{ab}	6.83 ^{b}	85.83 ^{bc}	3.33 ^{b}	2638.87 ^{a}
SAMSORG-39	10.56 ^{c}	1.31 ^{f}	5.83 ^{ab}	6.33 ^{b}	86.17 ^{bc}	3.17 ^{b}	2246.36 ^{b}
Tiksha-Mamza (Ex-Garkida)	10.72 ^{c}	1.77 ^{d}	7.17 ^{a}	10.50 ^{a}	83.83 ^{c}	9.83 ^{a}	1940.90 ^{c}
Ex-Tula red cultivar	11.50 ^{ab}	4.36 ^{a}	4.17 ^{b}	3.50 ^{c}	92.17 ^{a}	2.50 ^{b}	1932.55 ^{c}
Ex-Tula Farafara cultivar	11.83 ^{a}	4.25 ^{b}	4.50 ^{b}	3.67 ^{c}	92.83 ^{a}	1.33 ^{b}	1800.84 ^{c}
Mean	10.88	2.45	5.69	6.92	87.42	3.44	2162.42
CV (%)	6.69	5.56	21.76	16.41	4.29	43.57	12.54
S.E	0.73	0.14	1.24	1.13	3.75	1.50	271.26

Means with the same letter are not significantly different at P = 0.05 using Student-Newman-Kuels (SNK) test for variables

Table 4: Mean Performance of Sorghum at Three Levels of Treatments at Yola and Kalungo and the Combined in 2011 Cropping Season

Treatments	Yola			Kaltungo			Combined		
	Number of leaves	Plant height	Yield (Kg/ha)	Number of leaves	Plant height	Yield (Kg/ha)	Number of leaves	Plant height	Yield (Kg/ha)
Treated with Carbofuran	10.67 ^{a}	2.44 ^{a}	2669.93 ^{a}	11.00 ^{a}	2.41 ^{a}	2637.09 ^{a}	10.83 ^{a}	2.43 ^{a}	2653.51 ^{a}
Protected with head cage	10.67 ^{a}	2.47 ^{a}	2363.66 ^{b}	11.17 ^{a}	2.42 ^{a}	1740.68 ^{b}	10.92 ^{a}	2.44 ^{a}	2052.17 ^{b}
Untreated	10.75 ^{a}	2.50 ^{a}	1988.25 ^{c}	11.00 ^{a}	2.44 ^{a}	1574.88 ^{c}	10.86 ^{a}	2.47 ^{a}	1781.57 ^{c}
Means	10.69	2.47	2340.66	11.06	2.42	1984.22	10.88	2.45	2162.42
CV (%)	6.82	5.40	12.69	6.05	5.81	12.42	6.69	5.56	12.54
S.E	0.73	0.13	297.03	0.67	0.14	246.36	0.73	0.14	271.26

Means with the same letter are not significantly different at P = 0.05 using Student-Newman-Kuels (SNK) test for variables

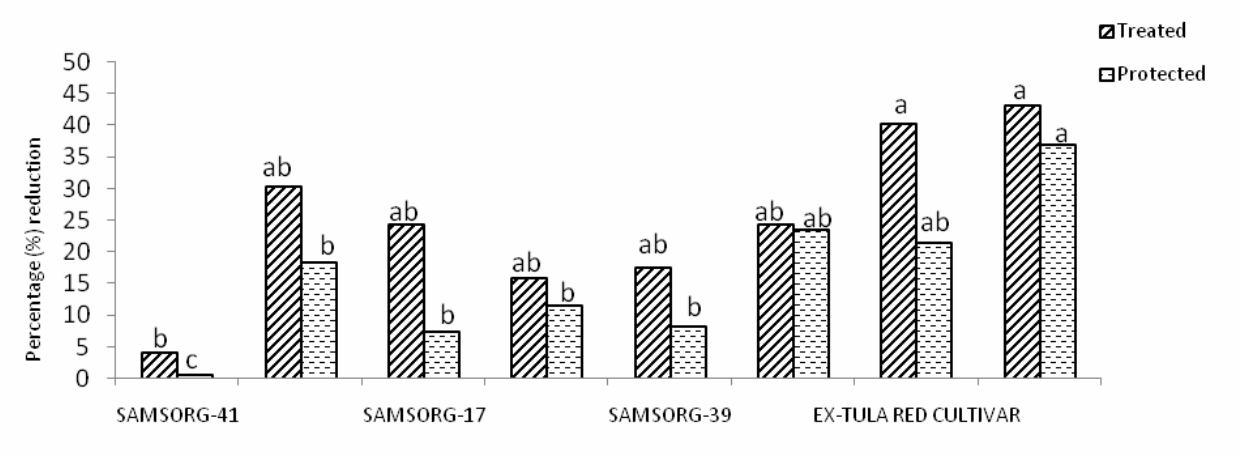

Fig 1: Percentage % reduction in grain yield on eight sorghum varieties in 2011 cropping season at Yola

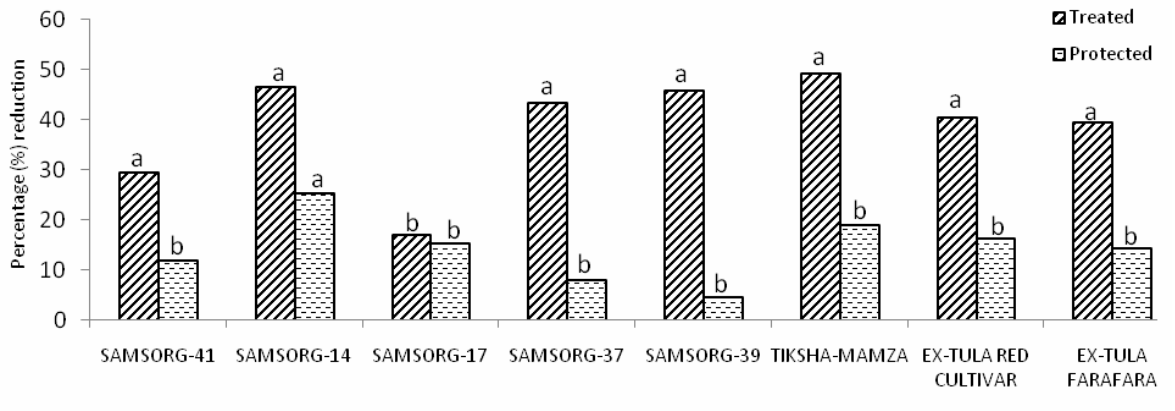

Fig 2: Percentage % reduction in Grain yield on eight Sorghum varieties in 2011 cropping season at Kaltungo

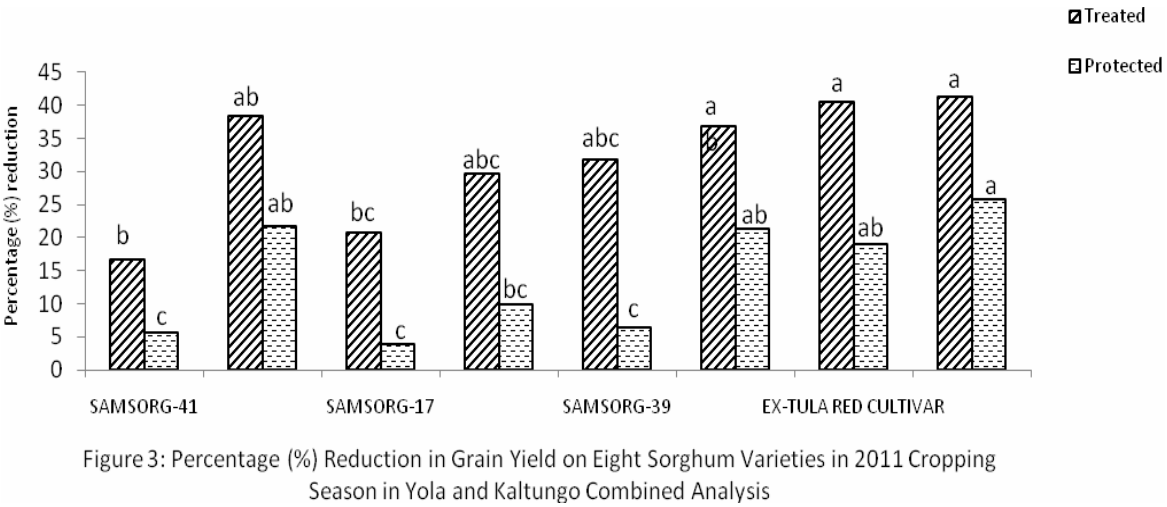

Figure 3: Percentage (%) Reduction in Grain Yield on Eight Sorghum Varieties in 2011 Cropping Season in Yola and Kaltungo Combined Analysis

Fig 3: Percentage % reduction in Grain yield on eight Sorghum varieties in 2011 cropping season in Yola and kaltungo Combined Analysis

Plate 1: A typical damage inflicted by stink bug Agnoscelis versicola F. (Hemiptera: Pentatomidae) on SAMSORG-39.

Plate 2: A typical damage inflicted by pod sucking bug Mirperus jaculatus (Hemiptera: Alydidae) on SAMSORG-41.

Plate 3: A typical damage inflicted by panicle insect pests on SAMSORG-41.

4. DISCUSSION

Panicle insect pests damage decreased grain yield, seed germination and increased floaters, moldiness and result to discoloration and punctures. Panicle insect pests damaged grains may be unfit for human consumption, due to reduction in grain quality. This agrees with Malgwi et al. [11] and Sharma et al. [19]. Sharma et al. [19] further reported that damaged grain by panicle insect pests is of poor nutritional quality, poor seedling establishment and vigor. The result obtained at Yola and Kaltungo showed that panicle insect pests caused up to 41.40% yield loss when compared to natural infestation panicle with treated panicle with carbofuran. This also agrees with the findings carried out by Malwi [9], Malgwi et al. [11], Sharma et al. [19] and Steck et al. [20]. The mean performance of sorghum at three level of treatment showed a significant difference between treatments. Even though carbofuran has mostly been used for the control of stem borers, but it was effective in the

control of panicle insect pests of sorghum as well. Most of the insecticide used earlier was cypermethrin [2], but was not strong enough to keep sorghum free from the panicle insect pests as compared to carbofuran that killed not only panicle pests, but other soil borne pests and that of the stem as well. The application of cypermethrin is cumbersome since it is a spray formulation, while carbofuran is a lot easier as a granular pesticide applied in the whorls of sorghum which was directly absorbed into the plant system. Also, the combined analysis for Yola and Kaltungo showed yield per hectare of 2,653.51 $kgha^{-1}$ (2.7 tons ha^{-1}) when treated with carbofuran. This agreed with Ajayi [2] and Idem and Showemimo [8] who recorded that it is possible to obtain sorghum yield of 1.5-3.5 tons ha^{-1} in Nigeria under good pest management practice. When protected with cages, the mean yield of (2,052.17 $kgha^{-1}$) was obtained as when the panicles were left for natural infestation, a yielded of (1,781.57 $kgha^{-1}$) was obtained. Therefore, carbofuran was found effective in the control of panicle insect pests.

However, carbofuran which is easy to apply has to be used with caution, since it could kill almost all pests, it is dangerous and accidental ingestion could lead to death of the person applying it. Also, applying it as band treatment may be dangerous, as it may run into water ways and down the food chain which is dangerous to man and its environment. Therefore, farmers must be properly educated in order to benefit the use of carbofuran for control of pests in general.

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