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Species Complex and Seasonal Abundance of Panicle Pests of Sorghum, *Sorghum bicolor (L.)* (Moench) in North-Eastern Nigeria

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Authors' contributions

This research was carried out by both authors DMD and AMM. The experiment was designed, supervised, proof read, sent for publication and paid by author AMM. The experiment was carried out with data collection and the first draft written by author DMD. Both authors contributed for the literature. The final write up was done by AMM. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: The species complex and abundance of panicle pests of sorghum was studied on eight sorghum varieties and cultivars in field trial in order identify the pest spectrum complexity on sorghum and at what time of the season they are in abundance and identify which of the sorghum varieties supports fewer pests and incorporate it in integrated pest management programme (IPM) for future studies.
Study Design: The experiment was laid in a randomized complete block design (RCBD) which was replicated 3 times on 12m2 plots consisting of eight sorghum varieties and cultivars.

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Place and Duration of Study: The field trial was conducted in two locations at Yola, Adamawa State and Kaltungo, Gombe State in 2011 cropping season in North-eastern Nigeria.
Methodology: Data was collected as from Complete Anthesis Stage (CAS) in September up to Hard Dough Stage (HDS) of sorghum development in November ending. Ten panicles /plot were sampled using transparent polythene bags.
Results: During this trial, 21 pests were identified, but only 18 were common at both Yola and Kaltungo. At both locations three of the pests found were different. Insects identified in order of their abundance were: *Eurystylus oldi, Sitophilus zeamais, Monolepta sp., Orius sp., Nola sorghiella*, *Agnoscelis versicola, Mirperus jaculus, Spilostethus sp., Nezara viridula, Campylomma sp., Achaearanea tepidoriorum, Forficula senegalensis, Apis mellifera, Messor sp., Erythroneura variabilis, Poophilus costalis, Apocrita polistes, Kraussaria angulifera, Pachnoda chordata, Mantis religiosa* and *Silidius apicalis*. The variety that haboured the highest population of pests was SAMSORG-17 at Yola with a mean population of (609.68/10 panicles) and the least was on Tiksha-Mamza (Ex-Garkida) with a population of (153.33/10 panicles). At Kaltungo, it was SAMSORG-14 haboured the highest population of panicle insect pests (834.34/10 panicles) and the least was on Ex-Tula Farafara cultivar (182.34/10 panicles).The cultivars (Tiksha-mamza, Ex-Tula red and farafara) haboured fewer pests and are more promising than the Samsorgs (14, 17, 37, 39 and 41) improved varieties that haboured more pests. Peak population was in mid-october at soft dough stage.
Conclusion: The local cultivars were more promising than the Samsorg varieties which could be improved for further studies to plant breeders and planting dates could be manipulated to escape period of high pests abundance and hence incorporated in IPM programme as a recommendation for further studies.

Keywords: Pests; species; sorghum; varieties; abundance; panicle; Nigeria.

1. INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) belongs to the family Poaceae and originated in Africa which is the fifth world most important crop after wheat, rice and barley [1-3]. Millions of people living in semi-arid tropic especially in Africa, Asia and India depend on sorghum as a staple food [4]. Sorghum is faced with many important problems that lead to large yield losses especially caused by parasitic weeds (especially *Striga hermonthica*) anthracnose, downy mildew, grain moulds and sorghum midge and stem bores [5]. The crop is also attacked by a wide and complex range of insect pests worldwide and the total pests load in any area can be very heavy. In spite of the importance of the crop there are few reports on different aspects of sorghum insect pests; progress has been low because of the perceived low market value of the sorghum in developing countries [6,7,2,3]. Insect pests are a major constraint to increased sorghum production in West Africa, with over 100 species recorded, of which more than 40 are panicle -feeding pests [8-12]. In Nigeria, insect pests attacked sorghum at virtually all phonological Stages.

However, only a few of the these are considered to be economically important pests in West Africa, among which are stem borers, Sorghum midge, shoofly, spittle bugs and a complex of pentatomid and mirid head bugs [13-15,2,16,12]. Panicle infesting insects, feed directly on the reproductive parts of cereal, they often cause direct and irreversible damage [16]. However, [12] further stated that, in Africa, there are few isolate reports which have been

documented more specifically on head bugs, but no detailed reports on the species complex and their abundance. However it is believed that improved varieties hold a key to increased and sustainable sorghum production because they combine early maturity with higher yield and have better potential for commercial exploitation and industrial use than the local cultivars. Therefore the need to develop effective management practices for sorghum panicle feeders cannot be over emphasized [11].

This paper, reports on species complex and abundance of panicle pests on different sorghum varieties and cultivars, with the aim of suggesting some peak period of abundance and when to escape high damage which could be incorporated in integrated pest management programme.

2. MATERIALS AND METHODS

2.1 Site Description

Field trials were established at the teaching and research farm of the Department of Crop Protection, Modibbo Adama University of Technology, Yola and school farm of Government Girls' Secondary School Kaltungo, Gombe state. Yola is located within latitute 9º11^{1}N to 9º19^{1}N and longitude 12º31^{1}E [17] and Kaltungo is located within latitude 9º48^{1}N to 9º51^{1}N and longitude 11º18^{1}E to 11º32^{1}E [18] both in Guinea savanna zone of Nigeria during 2011 cropping season.

2.2 Sorghum Varieties and Cultivars

Eight varieties and cultivars of sorghum were obtained from three sources. Five of the varieties (SAMSORG-41, SAMSORG-14, SAMSORG-17, SAMSORG-37 and SAMSORG-39) were obtained from the Institute for Agricultural Research (IAR)/Ahmadu Bello University (ABU) Samaru, Zaria, one cultivar Tiksha Mamza (Ex-Garkida) was obtained from Garkida and two cultivars (Ex-Tula Red Cultivar and Ex-Tula Farafara) were obtained from Tula. This varieties and cultivars characteristic have already been described and discussed [19,20].

2.3 Experimental Design

The experiment was laid out in a randomized complete block design (RCBD) replicated three times with varieties and cultivars of sorghum mentioned above as the treatments. Each replication was separated by 2m apart and inter - plot spacing was 1.5m while the plot size was 3x4m^2 (12m^2). The intra-plot spacing was 0.4m and inter-plot spacing was 0.75m.

2.4 Cultural Practices

The fields were ploughed with a tractor mould-board plough. The fields were later marked out as earlier mentioned. Apron star 50 DS (Metal-axyl 10%, carboxin 6% +furathiocarb 34%) at the rate of 1 sachet per 10kg of sorghum seeds 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 because the distance is more about 246km from Yola since the sampling and data collection of pests have to be carried out in the morning hours. The dressed seeds were sown on the prepared plots in holes of depth of 2cm at the rate of 4-6 seeds per hole. The plants were later thinned to 2 plants per stand at two weeks after emergence. Split application of fertilizer NPK 15:15:15 was applied at four and eight weeks

after emergence at the rate of 64kg Nha^{-1}. Manual hoe weeding was carried out two times depending on the weed infestation and followed by earthening around the sorghum stands in order to prevent lodging of the sorghum plants.

2.5 Sampling of Pests, Predators and Pollinators

Sampling and pests collection was carried out in the morning hours (06:00-08:30hrs) when the pests were at rest or inactive using transparent polythene bags size measuring 54cm (0.5m) length and 36cm (0.36m) width as described by [21-23,12]. The date of the Sampling varied with the varieties and cultivars depending on the date of flowering, maturity and location. This was done on weekly basis from September to November ending (from CAS to HDS of sorghum development) in each location. Due to the distance in site from Yola to Kaltingo which is about 246km, time of data sampling of 48hours was spaced to allow effective data collection since this has to be carried out in the early morning hours before sun set. Ten (10) panicles were sampled randomly per plot on a weekly basis and the pests were collected by shaking each panicle vigorously into the polythene bags. The insects were immobilized by placing a cotton wool swab with chloroform to prevent flying pests from jumping out while collecting the other panicles using same polythene bag to sample 10 panicles per plot. The contents of the polythene bags were taken to the laboratory and were sorted out, counted and recorded. Identification of pests was done at the Institute for Agricultural Research/Ahmadu Bello Zaria Insect Museum with the help of the insect reference collection boxes/cabinets and the Curator. The larvae found in each of the sampled panicles was later collected in insect rearing jars of capacity 1liter with fragments of sorghum panicle at soft dough stage reared to adult for clarity in identification.

2.6 Statistical Analysis

The data obtained on the eight sorghum varieties and cultivars were subjected to Analysis of Variance (ANOVA) using (23) 12 Software Version 8 (2) and Student-Newman-Keuls (SNK) was used to separate the means at P=.05 test for variables.

3. RESULTS AND DISCUSSION

The result for the species complex for both locations (Yola and Kaltungo) showed that 21 species of pests were identified. This include: *Monolepta* sp., *Spilostethus* sp. (Stal), *Eurystylus oldi* (Poppius), *Nola sorghiella* (Riley), *Agnocelis versicola* (Thumberg), *Compylomma* sp. (Odhianbo), *Erythroneura variabilis, Mirperus jaculatus* (Thumberg), *Messor* sp. (Emery), *Pachnoda chordata* (Olivier), *Sitophilus zeamais* (Motschusky), *Poophilus costalis* (Walker), *Kraussaria angulifera* (Krauss), *Nezara viridula* (Linnaeus) and *Silidius apicalis*) are pests; (*Achaearanea tepidariorum, Orius* sp., *Forficula senegalensis* (Serville) and *Mantis religiosa*) are predators and (*Apis millifera)* and (*Apocrita polistes*) are pollinators (Table 1). *A. polistes* though a pollinator, but is also a parasitoid, because it was found feeding on developing grains and deposit some exudates which leads to growth and development of mould on the sorghum grains.

However, it has been well documented [24] that honey bees, *A. mellifera* and Wasp, *A. polistes* are well-known pollinators and they occurred during the anthesis stage of sorghum development, these are not pests except they sting human beings working on the farm. *Orius* sp. and preying mantis, *M. religiosa,* occurred in abundance at complete anthesis and milk stages of sorghum development, while earwigs, *F. senegalensis* occurred at soft dough

stage of sorghum development in low population. Spiders, *A. tepidariorum* were found at all stages of sorghum development which they are not pests, but a predator mostly on headbugs and these findings also agree with [24,25,8,26,2,12].

Table 1. Species complex identified in sorghum panicle

Species	Order	Family	Stage found	Pest Status
Monolepta sp.	Coleoptera	Chrysomelidae	Adult	Pest
Spilostethus sp.	Heteroptera	Lygaeidae	Adult	Pest
Eurystylus oldi	Hemiptera	Miridae	Adult & nymphs	Pest
Nola sorghiella	Lepidoptera	Nolidae	Larva & flying Adult	Pest
Agnoscelis versicola	Hemiptera	Pentatomidae	Adult & nymph	Pest
Campylomma sp.	Hemiptera	Miridae	Adult & nymph	Pest
Erythroneura variabilis	Hemiptera	Cicadellidae	Adult & nymph	Pest
Mirperus jaculus	Hemiptera	Alydidae	Adult & nymph	Pest
Messor sp.	Hymenoptera	Formicidae	Adult	Pest
Pachnoda cordata	Coleoptera	Scarabaeidae	Adult	Pest
Sitophilus zeamais	Coleoptera	Curculionidae	Larvae & Adult	Pest
Poophilus costalis	Hemiptera	Aphrophoridae	Adult & nymph	Pest
Kraussaria angulifera	Orthoptera	Acrididae	Adult & nymph	Pest
Nezara viridula	Hemiptera	Pentatomidae	Adult	Pest
Silidius apicalis	Coleoptera	Cantharidae	Adult	Pest
Achaearanea tepidariorum	Theridiidae	Araneae	Adult	Predator
Orius sp.	Hemiptera	Anthocoridae	Adult	Predator
Forficula senegalensis	Dermaptera	Forficulidae	Adult	Predator
Mantis religiosa	Dictyoptera	Mantoidae	Adult	Predator
Apis mellifera	Hymenoptera	Apidae	Adult	Pollinator
Apocrita polistes	Hymenoptera	Vespidae	Adult	Pollinator/pest/ Parasitoid

The result showed that, weekly population trend of panicle pests in the two locations (Yola and Kaltungo) differs slightly. At Yola, it was the 7th week (24 October) that had the highest population of insect pests (60.50), the lowest population of pests was recorded in the 12th week (28 November) (0.75) while at Kaltungo the highest population was recorded in the 6th week (17 October) (100.38) and the lowest population in the 11th week (21 November) (1.46). When the two locations were combined, it was the 6th week (17 October) with the highest population of about 74.65 and the lowest in the 12th week (28 November) with 1.45 (Table 2). The finding also corroborates the earlier results of [2,8,12], that panicle insects/ pests usually peak at mid-October which coincides with the SDS of sorghum development. This signifies the point at which control measures should be initiated before the pest situation reaches economic damage.

The chrysomelid beetle, *Monolepta* sp. occurred in abundance at Yola and mostly on Ex-Tula farafara cultivar, sap sucking bug, *Spilostethus* sp.; headbug, *E. oldi* the insect pest that has the highest population count and SAMSORG-14 haboured these pests in high populations both at Yola and Kaltungo. This corroborates the findings of [2,1] that among the panicle pests found in West Africa, most especially Nigeria, *E. oldi* remained the most abundant and important in reducing sorghum grain quality. The webworm, *N. sorghiella* were found on sorghum panicles which formed webs on developing grains that further contaminates the quality of the grains. The stink bug, *A. versicola*; head bug, *Campylomma* sp.; hoppers, *E. variabilis*; pod sucking bug *M. jaculus*; harvester ant, *Messor* sp.; pod sucking bug, *P. cordata* and maize weevil, *S. zeamais* were common in both locations and

were common on all the varieties at SDS. *Campylomma* sp. and *M. jaculus* are sap suckers, while the rest were found feeding on the grains which are typical of their characteristics as earlier documented by [7-11]. The *S. zeamais,* spittle bug, *P. costalis* and grasshopper, *K. angulifera* occurred in abundance only in Kaltungo. The green stink bug, *N. viridula* and *S. apicalis* were only found in Yola. *N. viridula* occurred only on SAMSORG-17. The differences in specie and abundance of pests in Yola and Kaltungo could be due to the differences in geographical zones regarding rainfall and probably temperature. Such differences also validate the findings of [27,2,28], who found that geographical locations could affect pests population negatively or positively depending on the habitat, rainfall patterns, temperature and relative humidity at a point in time when data was collected.

The mean cumulative pests on the eight sorghum varieties and cultivars in 2011 cropping season in the two locations (Yola and Kaltungo) are presented in Table 3. At Yola, the variety that haboured the highest population was SAMSORG-17 with 50.81/10 panicles, followed by Ex-Tula Farafara cultivar (46.19/10panicles), SAMSORG-14 (44.56/10 panicles) and least was on Tiksha-Mamza (Ex-Garkida) (12.78/10 panicles). At Kaltungo, it was SAMSORG-14 had the highest population of 69.53/10 panicles followed by SAMSORG-37 (52.19/10 panicles), and the least was on Ex-Tula Farafara cultivar (15.19/10 panicles). In the combined analysis, SAMSORG-14 was leading in the population of insect pests with (57.04/10 panicles) followed by SAMSORG-17 (44.10/10 panicles) and the least occurred in Tiksha-Mamza (Ex-Garkida) with a population of insect pests 19.11/10 panicles (Table 3).

Table 2. Mean weekly population of pests (individual panicle /10 panicles) of sorghum in 2011 cropping season in the two locations

Time of the year	Yola	Kaltungo	Combined analysis
12 and 14 Sept.	10.33^{de}	3.54^{d}	6.94^{f}
19 and 21 Sept.	22.54^{cd}	18.38^{c}	20.46^{e}
26 and 28 Sept.	31.38^{c}	26.67^{c}	29.02^{de}
3 and 5 Oct.	20.83^{cd}	57.25^{b}	39.04^{c}
10 and 12 Oct.	45.83^{ab}	52.04^{b}	48.94^{b}
17 and 19 Oct.	47.75^{ab}	100.38^{a}	74.06^{a}
24 and 26 Oct.	60.50^{a}	30.17^{c}	45.33^{bc}
31 Oct. and 2 Nov.	50.83^{ab}	96.46^{a}	73.65^{a}
7 and 9 Nov.	49.29^{ab}	24.54^{c}	36.92^{cd}
14 and 16 Nov.	35.13^{bc}	4.29^{d}	19.71^{e}
21 and 23 Nov.	1.88^{e}	1.46^{d}	1.67^{f}
28 and 30 Nov.	0.75^{e}	1.54^{d}	1.45^{f}
Mean	31.42	34.73	33.07
Coefficient of variability-CV (%)	66.99	33.38	59.82
±Standard error (SE)	21.05	18.54	19.78

Means with the same letter(s) are not significantly different at P=.05 using Student-Newman-Keuls (SNK) test for variables

Species complex and abundance of pests at Yola and Kaltungo in 2011 cropping season are presented in Table 4. At Yola, *Monolepta* sp. was the highest insect species that occurred (2.60) followed by *E. oldi* (2.38) and the least was *M. religiosa.* At Kaltungo, *Eurystylus oldi* was the highest insect species followed by *Monolepta* sp. (1.28) with the least in *Pachnoda chordata* (0.72) (Table 4).

The species complex and abundance of panicle pests on eight sorghum varieties per week in location 1 (Yola) and location 2 (Kaltungo) in 2011 cropping season and the combined

analysis are presented in Figs. 1, 2 and 3 respectively. In Fig. 2, the peak population of *E. oldi* occurred on 12 October with a mean population of 4.24. Population of *Monolepta* sp. was high on 19 October with a mean population of 4.24. The lowest population of species occurred at the last stage of sorghum development, from 23 to 30 November and it was the hard dough stage of the sorghum development.

Table 3. Mean cumulative no. of pests (individual/10 panicles) on sorghum varieties in 2011 cropping season in two locations

Varieties	Yola	Kaltungo	Combined analysis
SAMSORG-41	21.94^{bc}	25.58^{de}	23.76^{cd}
SAMSORG-14	44.56^{a}	69.53^{a}	57.04^{a}
SAMSORG-17	50.81^{a}	37.39^{c}	44.10^{b}
SAMSORG-37	27.97^{b}	52.19^{b}	40.08^{b}
SAMSORG-39	18.75^{bc}	32.53^{cd}	25.64^{cd}
Tiksha-Mamza (Ex-Garkida	12.78^{c}	25.44^{de}	19.11^{d}
Ex-Tula Red Cultivar	28.36^{b}	19.94^{e}	24.15^{cd}
Ex-Tula Farafara Cultivar	46.19^{a}	15.19^{e}	30.69^{c}
Mean	31.42	34.73	33.07
Coefficient of variability-CV (%)	66.99	53.38	59.82
±Standard error (SE)	21.05	18.54	19.78

Means with the same letter are not significantly different at P=.05 using Student-Newman-Kuels (SNK) test for variables

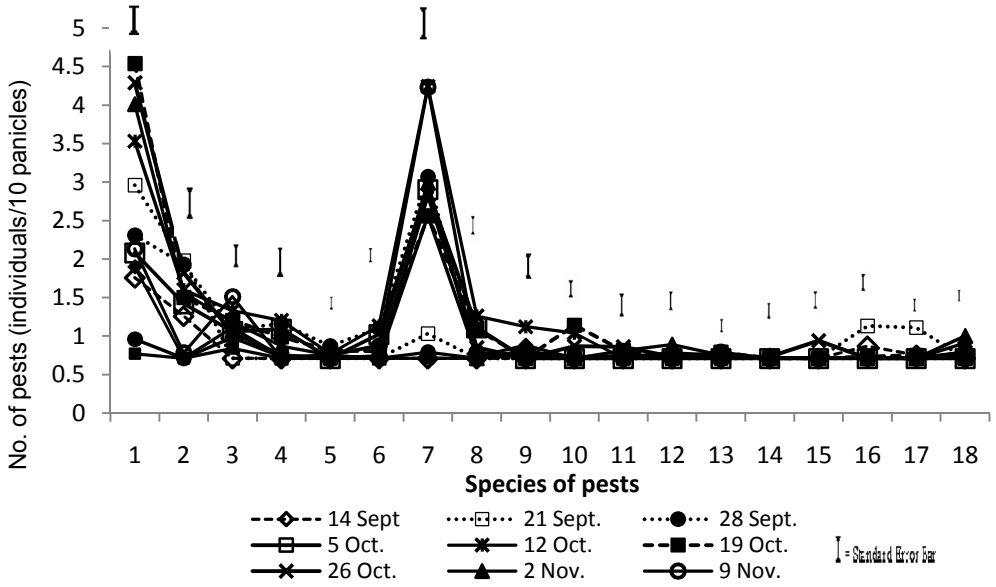

Fig. 1. Species complex and abundance of pests per week on sorghum in 2011 cropping season at Yola

Key 1 = Monolepta sp. 8 = Nola sorghiella 15 = Pachnoda cordata 2 = Apis mellifera 9 = Agnoscelis versicola 16 = Silidius apicalis 3 = Achaearanea tepidariorum 10 = Campylomma sp. 17 = Apocrita polistes 4 = Spilostethus sp. 11= Erythroneura variabilis 18 = Nezara viridula 5 = Orius sp. 12 = Mirperus jaculus 6 = Forficula senegalensis13 = Messor sp. 7 = Eurystylus oldi14 = Mantis religiosa

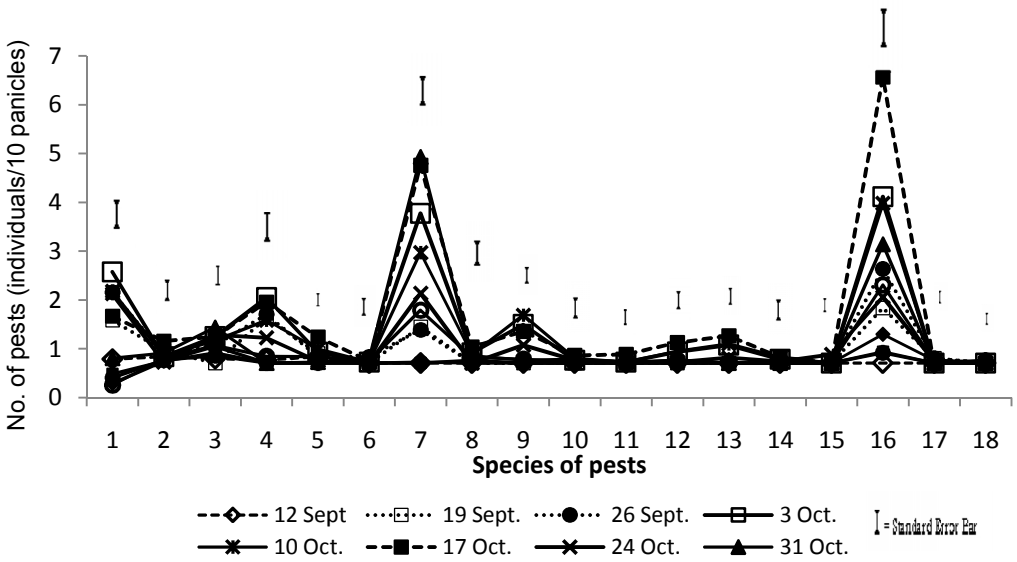

Fig. 2. Species complex and abundance of pests per week on sorghum in 2011 cropping season at Kaltungo

Key: 1 = Monolepta sp. 8 = Nola sorghiella15 = Pachnoda cordata 2 = Apis mellifera 9 = Agnoscelis versicola16 = Sitophilus zeamais 3 = Achaearanea tepidariorum 10 = Campylomma sp. 17 = Poophilus costalis 4 = Spilostethus sp. 11= Erythroneura variabilis 18=Kraussaria angulifera 5 = Orius sp. 12 = Mirperus jaculus 6 = Forficula senegalensis 13 = Messor sp. 7 = Eurystylus oldi 14 = Mantis religiosa

Table 4. Species complex and abundance of pests (mean no. of individuals/l0 panicles/plot) on sorghum varieties in the two locations in 2011 cropping season

Species	Yola	Kaltungo	Mean	CV (%)	±SE
Monolepta sp.	2.60^{a}	1.28^{ab}	1.94	39.44	0.77
Apis mellifera	1.33^{ab}	0.86^{b}	1.09	47.07	0.51
Achaearanea tepidariorum	1.06^{ab}	1.07^{b}	1.07	26.30	0.28
Spilostethus sp.	0.86^{b}	1.22^{ab}	1.04	36.06	0.78
Orius sp.	0.74^{b}	0.85^{b}	0.80	22.78	0.18
Forficula senegalensis	0.85^{b}	0.74^{b}	0.80	22.78	0.18
Eurystylus oldi	2.38^{a}	2.17^{a}	2.28	42.31	0.81
Nola sorghiella	0.84^{b}	0.80^{b}	0.82	22.67	0.19
Oebalus gugnax	0.78^{b}	0.95^{b}	0.86	26.30	0.23
Campylomma sp.	0.78^{b}	0.75^{b}	0.77	28.46	0.22
Erythroneura variabilis	0.75^{b}	0.73^{b}	0.74	15.69	0.12
Mirperus jaculus	0.74^{b}	0.79^{b}	0.76	17.98	0.14
Messor sp.	0.73^{b}	0.83^{b}	0.78	16.62	0.13
Mantis religiosa	0.71^{b}	0.74^{b}	0.72	13.17	0.10
Pachnoda cordata	0.73^{b}	0.72^{b}	0.72	11.45	0.08

Means with the same letter are not significantly different at P=.05 using Student-Newman-Kuels (SNK) test for variables

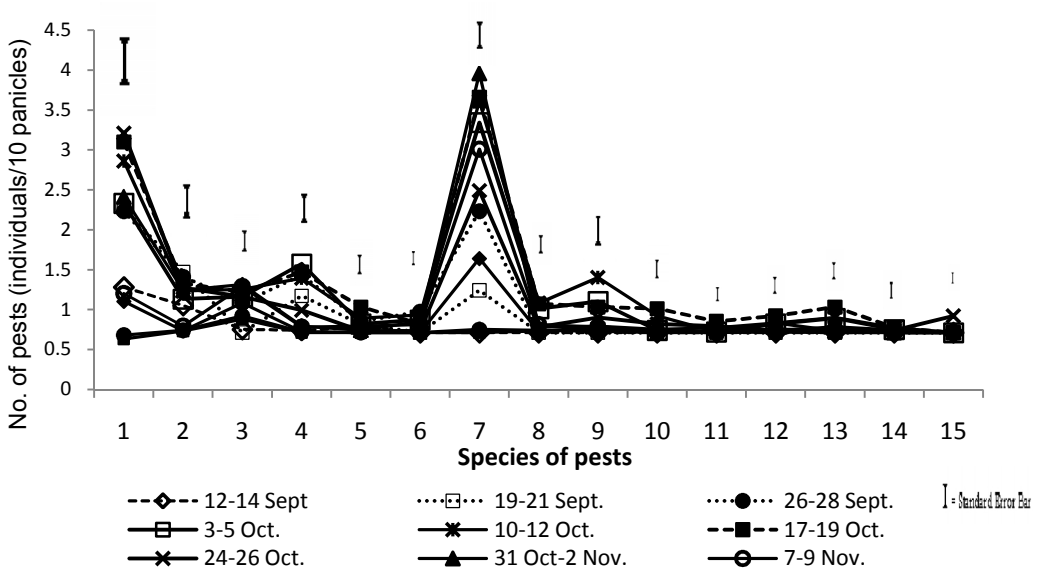

Fig. 3. Species complex and abundance of pests per week on sorghum in 2011 cropping season in combined analysis

Key: 1 = Monolepta sp. 8 = Nola sorghiella 15 = Pachnoda cordata 2 = Apis mellifera 9 = Agnoscelis versicola 3 = Achaearanea tepidariorum 10 = Campylomma sp. 4 = Spilostethus sp. 11= Erythroneura variabilis 5 = Orius sp. 12 = Mirperus jaculus; 6 = Forficula senegalensis 13 = Messor sp. 7 = Eurystylus oldi 14 = Mantis religiosa

In Fig. 3, the peak population of *E. oldi* occurred on 31 October with a mean population of 4.93 and *S. zeamais* occurred on 17 October with a mean population of 6.57. These pests were found to be higher in 17 October and 31 October (milk stage and soft dough stage). 21 November and 28 November supported the lowest insect population in the sorghum (hard dough stage). In Fig. 3, which is the combined analysis the pests that was higher in all the weeks was *E. oldi, Orius* sp. and *Monolepta* sp. and where *Orius* sp. was high in the last week of September and first week of October at milk stage of sorghum the head bug population decreased especially *E. oldi*, and this validates [2]. The lowest insect population of were *M. religiosa* and *P. cordata*.

The results showed that, all the SAMSORG varieties, harbors more panicle insects, compared to the local cultivars of Ex-Garkida and Ex-Tula. These showed that, they are promising cultivars which could be resistant to panicle pests. Tiksha-Manza despite that it a semi-compact panicle, the red pigmentation which is high in tannin content might have been the reason that it was not favourable to panicle insect pests of sorghum, particularly *E. oldi*, which supported the earlier findings of [2,29] that red pigmented sorghum that are usually high in tannin content is unfavourable to panicle insect pests. The Ex-Tula(s) are tall, with loose-panicles which usually mature late and were not favourable for nesting of pests due to its pendulous panicles which matures late in the season. The height of Ex-Tula which matures late in the season usually coincides with the onset of harmattern period which comes with the strong North-east wind that is dry and cold, makes it almost impossible for

the pests to nest or hibernate freely in the panicles that are loose which could have been the reason for its low numbers or population. This finding also corroborates [2].

4. CONCLUSION

The results on the species complex and abundance of sorghum panicle pests is an important step in knowing the complexity and abundance of a whole pest spectrum on sorghum at different time in the season or year they appear mostly and at what growth stage of sorghum they appear; and which of the sorghum varieties harbors the highest panicle pests population. It is also a step that reveals planting dates could be manipulated to escape high incidence and damage due to insect pests of sorghum as earlier carried by [30] on *E. oldi*. For further studies, it is recommended that, detailed studies on each of the pests be investigated on different varieties and planted at different times to find out whether planting dates could be harmonized and manipulated to escape high populations thereby escaping pest damage. All the local cultivars [Tiksha mamza (Ex-Garkida) and the Ex-Tula red and farafara] which supports fewer number of pests should be of interest to plant breeders which could be developed and released to farmers than the SAMSORG varieties support more insects even though they mature early in the season.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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