Insects infesting sorghum (*Sorghum bicolor* L. Moench) panicles in northern Ghana. 1. Distribution, species composition, and damage potential

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ABSTRACT

Surveys in the Upper East Region showed that sorghum panicles were attacked by an insect pest complex of which midge, mirid and pentatomid bugs and head caterpillars were most prominent. Midge was most important on late-planted sorghums while mirid bugs constituted the main pests of early sorghums. The mirid bug complex (Heteroptera: Miridae) was dominated by *Eurystylus oldi* (Poppius), but *Creontiades pallidus* (Rambur), *Campylomma angustior* (Poppius), *Taylorilygus* sp. and *Megacoelum apicale* (Reuter) also proliferated on most farms. Important predators associated with head bugs included earwigs, *Forficula senegalensis* Serville (Demaptera: Forficulidae) and assassin bugs, especially *Cosmolestes pictus* Klug (Heteroptera: Reduviidae). Yield loss estimates showed that controlling either head bugs or midge alone increased grain yields by 23-35 and 26-38 per cent, respectively, while controlling both pests increased yield by up to 63 per cent. Farmers recognized panicle feeders as pests on their crops, but usually did not think they caused economic damage; hence, farmers made no conscious efforts to control them. This is probably because most of them grow local guinense-type sorghums, which are known to be less susceptible to panicle pests compared to the improved caudatum types.

Original scientific paper. Received 29 Mar 04; revised 04 Oct 05.

RÉSUMÉ

TANZUBIL, P. B., ALEM, A. & ZAKARIAH, M. : *Insectes infestant les panicules de sorgho* (Sorghum bicolor *L. Moench*) *dans le nord du Ghana. 1. La distribution, la constitution d'espèces et le potentiel de dégât.* Des sondages entrepris partout dans la Région d'Upper East révélaient que les panicules de sorgho sont ravagées par l'ensemble d'insecte ravageur dont le moucheron, le mirid, le pentatome (punaise de bois) et les chenilles sont plus marquants. Le moucheron était plus important sur les sorghos semés tardivement alors que les punaises mirids constituaient les ravageuses principales de sorghos tôt. L'ensemble de punaise mirid (Hétéroptère : Mirid) était dominé par *Eurystylus oldi* (Poppius), mais *Creontiades pallidus* (Rambur), *Campylomma angustior* (Poppius), *Taylorilygus* sp. et *Megacoelum apicale* (Reuter) aussi proliféraient sur la plupart de champs. Les prédateurs importants associés avec les punaises comprenaient les perce-oreilles, *Forficula senegalensis* Serville (Demaptera : Forficulidae) et les triatomes surtout *Cosmolestes pictus* Klug (Hétéroptère: Reduviidae). Les estimations de perte de rendement montraient que la lutte contre soit la punaise soit le moucheron seulement augmentait les rendements de grain par 23-35 et 26-38%, respectivement, alors que la lutte contre les deux ravageurs augmentait le rendement par jusqu'à 63% . Les agriculteurs reconnaissaient les mangeurs de panicule comme de ravageurs sur leurs cultures mais dans la plupart des cas ne pensaient pas qu'ils provoquaient des dommages à l'économie et ne faisaient donc pas aucun effort consciencieux pour lutter contre eux . C'est probablement à cause du type guinense local, qui sont reconnu d'être moins prédisposé aux ravageurs de panicule que les types de caudatum amélioré.

Introduction

Sorghum (*Sorghum bicolor* L. Moench) is one of the most important food crops in the savanna areas of Ghana. Although the potential yield on experimental stations exceeds 2000 kg ha^{-1}, farmers seldom harvest more than 600 kg ha^{-1} of sorghum grain from their fields**.** Insect pests are a major constraint to increased sorghum production in West Africa, with over 100 species recorded (Nwanze, 1985; McFarlane, 1989; Seshu Reddy, 1991). In Ghana, the plant is attacked by pests at virtually all phenological stages. However, only a few of these are considered to be economically important, among which are stem borers, shootfly, *Atherigona soccata*, Rondani (Diptera: Muscidae), spittle bugs, *Poophilus* spp., *Locris rubra (*Hemiptera : Aprophoidae), midge, *Stenodiplosis sorghicola* ,Coquillett (Diptera :Cecidomyiidae), and a complex of pentatomid and mirid head bugs (Bowden, 1965; Agyen-Sampong, 1978; Tanzubil & Dekuku, 1991; Tanzubil, 1997).

Because panicle-infesting insects feed directly on the reproductive parts of cereals, they often cause direct and irreversible damage. They are, therefore, often considered economic pests and their attack results in yield and quality losses. Changes in varietal susceptibility and farming systems have, over the years, induced a greater incidence of panicle-feeding insects, resulting in low adoption of improved varieties by farmers (Tanzubil, Zakaria & Alem, 2005). However, these improved varieties are believed to hold the key to increased and sustainable sorghum production because they combine early maturity with higher yields, and have better potentials for commercial exploitation and industrial use than the local varieties. Therefore, the need to develop effective management practices for panicle feeders cannot be overemphasized.

This study aimed at developing sustainable integrated pest management (IPM) systems for key pests of sorghum in the country.

Materials and methods

Surveys

Field surveys and farmer interviews were used in all six districts of the Upper East Region (UER) between July and December 2003 to determine the distribution, species composition, and relative abundance of insect pests attacking sorghum panicles. The UER was chosen because it is the area of most intensive cultivation of sorghum in the country, with farmers growing early and late types of sorghum. Also, our preliminary observations had shown that the pest complex on sorghum was similar throughout northern Ghana, with the UER having the greatest diversity. In each district, 5 to 10 sorghum farms were randomly selected for the study with the assistance of the local office of Ministry of Food and Agriculture. The number of farms visited depended on the size of the district and intensity of sorghum cultivation. Site and farmer selection were guided by the variety of sorghum grown, history and intensity of cultivation of the crop, ecological variability, differences in cropping systems as well as ethnic and cultural differences, among others.

On each farm, 10 panicles were randomly selected at the milky and dough stages, covered with transparent polythene bags, severed from the plant and sent to the laboratory. All insects and other arthropods were then dislodged for analysis of species composition, population levels, natural enemy activity, and damage ratings. For each farm the variety grown, date of planting, cropping system and agronomic practices adopted by the farmer were recorded. Predation was also studied *via* visual observation.

Farmer interviews

The perceptions of the farmers on panicle pest infestation and damage to sorghum were also collected through the use of semi-structured interviews. Information collected included resource endowments, extension contact, scale of production, type of production system,

varieties grown, main pests and diseases, relative importance of head bugs and other panicle pests, control measures used, yields recorded and losses incurred. Results from such an exercise could help identify feasible control options that could be adopted under the farmers' circumstances and resources. Data collected were subjected to quantitative and qualitative analyses.

Yield loss assessments

Controlled experiments were used in 2002 and 2003 to assess the relative importance of, and quantify damage caused by the various groups of panicle pests. Three varieties, namely local *Kobori*, *Malisor 84-7* and *Kapaala*, were planted at the Manga Research Station to assess the nature and extent of yield losses caused by sorghum head insects, with emphasis on midge and mirid head bugs. The design was a split plot with planting dates (early June and early July) as main plots and varieties as sub-plots. Each treatment was replicated three times in plots consisting of five rows each 5 m long. At booting, 20 plants were tagged in each plot, from which five each were randomly selected at flowering and treated as follows:

i. covered with head cage from head exertion up to harvest (full protection)
ii. covered from head exertion to full anthesis (midge-controlled)
iii. covered from full anthesis to hard dough stage (head bug-controlled)
iv. not covered throughout reproductive development

At maturity, each head was harvested separately, and yield and damage due to midge and head bugs were assessed using procedures described by Ratnadass, Doumbia & Ajayi (1993).

Results

Field surveys

The surveys confirmed that sorghum panicles in all the study areas supported a pest complex of which midge, *Stenodiplosis sorghicola* (Corq.), mirid head bugs, and pentatomid bugs were most dominant (Table 1). On early sorghum, midge incidence was low and mirid head bugs dominated the pest complex on all farms sampled. Late-maturing sorghums, however, suffered more from midge damage than from mirid bugs.

The mirid bug complex was dominated by

TABLE 1

Mean Populations of Key Insect Pests Collected from 30 Panicles in Each of Five Districts of the UER (2003, Early Sorghum)

Insect/District	*Bongo*	*Bolga*	*B. East*	*K-Nankana*	*Builsa*	*Total*
Eurystylus oldi	191	93	313	175	74	846
Creontiades pallidus	64	23	22	12	10	131
Megacoelum apicale	23	11	224	19	21	298
Campylomma sp.	25	8	3	3	0	39
Taylorilygus sp.	8	12	24	3	15	62
Miperus jaculus	3	0	0	0	5	8
Aspavia armigera	1	0	4	5	4	14
Nezera viridula	2	1	0	2	8	13
Dysdercus volkeri	0	2	0	9	9	20
Caterpillars	18	5	5	17	14	59
Grasshoppers	8	3	1	3	1	16
S. sorghicola	8	0	0	2	2	12

Eurystylus oldi (Poppius), but *Creontiades pallidus* (Rambur), *Campylomma angustior* (Poppius), *Taylorilygus* sp., and *Megacoelum apicale* (Reuter) were also found in significant numbers (Fig. 1).

Pentatomid bugs were few in the samples extracted from sorghum panicles, though field observations showed high populations. The main species included *Miperus jaculus* (Thunberg), *Aspavia armigera* (Fabricius), *Riptortus dentipes* (Fabricius), and *Nezera viridula* (Linnaeus).

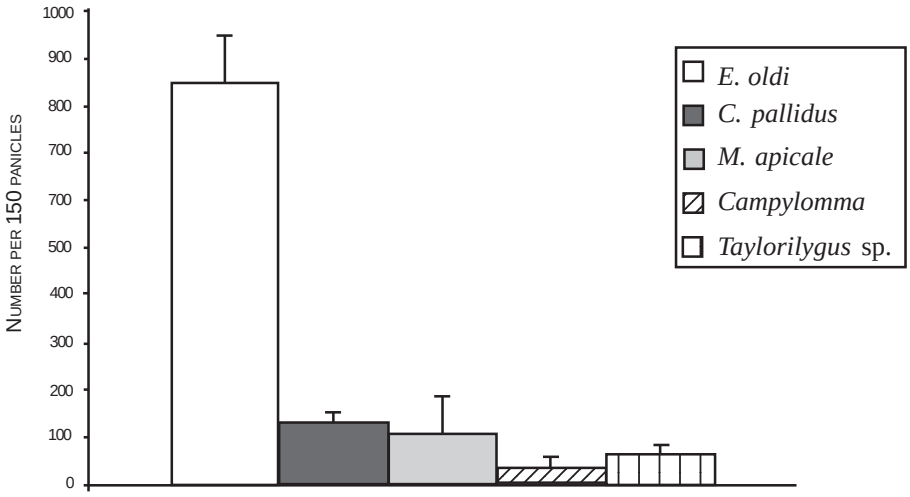

Fig. 1. Mean species composition of mirid bugs infesting sorghum panicles in the UER.

Earhead caterpillars constituted another important group of pests, with *Crypophelebia leucotreta* (Meyrick), *Cryptoblabes gnidiella (*Milliere), *Nola sorgiella* (Riley) and *Pyroderces hemizopha* (Meyrick) being the most common. Together with head bugs, these damaged developing grain substantially through direct feeding, production of frass and webbing.

Predatory arthropods recovered from sorghum panicles included assassin bugs (*Cosmolestes pictus* and *Rhynocoris segmentarius* (Germar), earwigs (*Forficula senegalensis,* Serville), and spiders (Fig. 2). Earwigs were recovered from each head examined, and sometimes up to 10 inhabited a single panicle. Though earwigs are sometimes considered as pests, observations in this study indicated that in sorghum panicles they fed on mirid bugs. Another predator occasionally encountered was the tree frog, *Hyperilus* sp.

Farmer interviews

Most farmers (53%) did not recognize head bugs as economic pests of sorghum, though 87% reported annual attack of their crops by these insects (Table 2). Bawku East recorded the highest responses (70%) for head bugs being important or very important followed by Bawku West (67%) while Bongo had the lowest, with only 20 per cent considering head bugs as important. Similarly, while 60 per cent of respondents in Bawku East thought the incidence of head bugs had increased over the past few years, most farmers in the other districts felt the trend in attack was either the same or fluctuating over the same period. None of the farmers interviewed took any measures to control panicle insects, except in the Bolga District where hand-picking was reportedly adopted against head caterpillars.

Yield loss assessments

Full control of all head insects resulted in 50

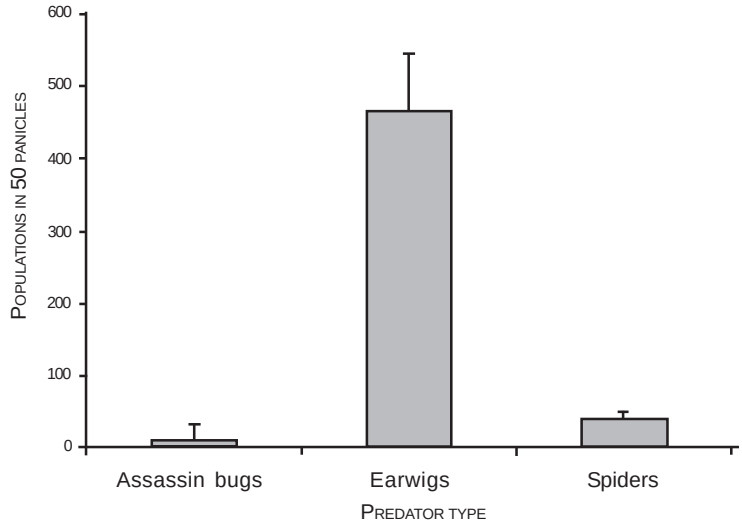

Fig. 2. Mean number of predators of panicle pests in the UER.

magnitude on farmer fields. This confirms the belief that this group of pests is economically important in sorghum production and needs to be controlled to guarantee sustainable sorghum production.

The reaction of the three varieties to control of the different insects varied significantly, though the trend was similar for both years (Tables 3 and 4). For the two improved varieties, *Malisor 84-7* benefited less from controlling midge or head bugs or both compared to

TABLE 2

Responses of Farmers on Sorghum Panicle Pests (% Frequency of Response)

Item	*Bolga*	*Bongo*	*Builsa*	*K-Nankana*	*B. East*	*B. West*	*Mean*
Importance of head bugs							
■ Very important	0.0	0.0	50.0	37.5	40.0	14.3	23.6
■ Important	33.3	20.0	0.0	12.5	30.0	42.9	23.1
■ Not important	66.7	80.0	50.0	50.0	30.0	42.9	53.3
Attacking crop every year?							
■ Yes	100	100	83.3	100	70.0	71.4	87.5
■ No	0.0	`0.0	16.7	0.0	30.0	28.6	12.6
Incidence over the years							
■ Increasing	33.3	20.0	16.7	0.0	60.0	42.9	28.8
■ Decreasing	16.7	0.0	0.0	0.0	10.0	0.0	4.5
■ Same	33.3	60.0	16.7	75.0	10.0	14.3	34.9
■ Fluctuating	16.7	20.0	66.7	25.0	20.0	42.9	31.9
Control measures adopted							
■ None	83.3	100	100	100	100.	100	97.2
■ Mechanical	16.7	0.0	0.0	0.0	0.0	0.0	2.8
Birds as pests	83.3	60.0	66.7	50.0	100	85.7	74.3

per cent yield increase over unprotected plots in both seasons (Tables 3 and 4). Controlling either midge or head bugs alone increased grain yields by 32 and 27 per cent, respectively, in 2002; while in 2003, the same practice resulted in 27 and 31 per cent yield increases, respectively. These results indicate that neglecting control of midge and head bugs could result in losses of such *Kapaala*. Controlling both insects resulted in 63 per cent yield increases in *Kapaala* during both seasons compared with 41 and 40 per cent in *Malisor 84-7* in 2002 and 2003, respectively (Tables 3 and 4). These suggest that *Malisor 84-7* is less susceptible to midge and head bugs than *Kapaala*. During the two seasons, head bug control resulted in less than 25 per cent yield

TABLE 3

Yield (grain weight per head) of Sorghum as Affected by Controlling Different Head Insect Pests (2002)

	Full control (a)	*Midge-controlled (b)*	*Head bug-controlled (c)*	*No control (d)*	*% increase (a over d)*	*% increase (b over d)*	*% increase (c over d)*
Kobori	67.7 ± 7.8	63.2 ± 9.2	55.4 ± 7.0	46.9 ± 3.6	44.3	34.5	18.1
Kapaala	75.5 ± 12.8	62.9 ± 4.6	65.1 ± 6.7	46.3 ± 8.4	63.1	35.9	40.6
Malisor	58.4 ± 5.8	51.7 ±10.2	49.8 ± 6.9	41.3 ± 8.7	41.4	25.2	20.6
Mean	67.2	59.3	56.8	44.8			
% yield increase	50.0	32.4	26.8	0			

TABLE 4

Yield (grain weight per head) of Sorghum as Affected by Controlling Different Head Insect Pests (2003)

	Full control (a)	*Midge-controlled (b)*	*Head bug-controlled (c)*	*No control (d)*	*% increase (a over d)*	*% increase (b over d)*	*% increase (c over d)*
Kobori	89.6 ± 2.4	78.9 ± 8.3	80.5 ± 4.8	60.8 ± 9.2	47.4	29.8	32.4
Kapaala	78.5 ± 5.3	66.4 ± 3.8	66.4 ± 5.6	48.2 ± 6.5	62.9	37.8	37.8
Malisor	77.8 ± 12.6	63.7 ± 8.0	68.8 ± 6.0	55.6 ± 7.3	39.9	14.6	23.7
Mean	82.0	69.7	71.9	54.9			
% yield increase	49.4	27.0	31.0	_			

increases in this variety compared with over 38 per cent for *Kapaala*. Similarly, midge control in *Malisor 84-7* increased grain yield by 15 to 25 per cent compared with 30 to 36 per cent in *Kapaala*.The local variety (*Kobori*) showed similar levels of susceptibility to head bugs as *Malisor 84-7*, especially in 2002, but was more susceptible to midge.

Discussion

Earlier studies in Ghana had recognized panicle-feeding insects as economic pests of sorghum. Bowden (1965) identified *S. sorghicola* and pentatomid bugs, *M. jaculus* and *Riptortus* spp., as the most important pests of sorghum panicles in northern Ghana.

Agyen-Sampong (1978) recorded 47 insect species associated with sorghum panicles at Nyankpala of which he singled out *Contarinia* (= *Setenodiplosis) sorghicola, Riptortus tenuicornis* (Dall.), and *Anoplocnemis curvipes* (Fabricius) as being most important. This study confirms the importance of midge and hemipteran head bugs as pests of sorghum. However, there has been a significant change in the pest profile over the years, with mirid head bugs now becoming more important than the pentatomids. None of the earlier studies mentioned mirid bugs as pests of sorghum. Mirid bugs feed and oviposit on developing sorghum grain, resulting in quantitative and qualitative losses. The action of digestive enzymes introduced into the grain during feeding further causes a breakdown of the endosperm, leading to loss of vitrosity. This change is probably associated with changes in varieties grown by farmers, from the local guinense types with loose droopy heads to the improved caudatum types with compact panicles.

Mirid bugs have recently become key pests of sorghum in the West African sub-region, with the genus *Eurystylus* dominating in most countries (Descamps, 1954; Nwanze, 1985; McFarlane, 1989; Doumbia & Bonzi, 1989; Gahukar, Doumbia & Bonzi, 1989). In a review of panicle pests of sorghum in West Africa, Ratnadass & Ajayi (1995) mentioned eight other mirid bugs as key pests. All the species of mirid bugs recorded in this study are included in this list, suggesting that the pest profile of sorghum is similar throughout the sorghum belt of the sub-region. Ratnadass *et al.* (1995) established an economic injury level (EIL) of 0.97 to 2.52 *E. immaculatus* per sorghum panicle in Mali. Table 1 clearly shows that most farms sampled in the six districts supported higher populations than the EIL. Such populations would cause economic injury if left uncontrolled.

Pentatomid bugs, especially *M. jaculus* and *A. armigera,* proliferated on all farms visited, though few were recovered from sampled panicles. This is because most of these are very active and, thus, would escape capture under the *whole panicle collection method* used. As observed by Agyen-Sampong (1978), these bugs pierce and suck sap from milky grain, causing them to shrivel. This leads to losses in grain quality and quantity.

Larvae of several lepidoptera have been reported to feed on sorghum panicles in West Africa. The main ones include *Helicoverpa armigera, Eublemma gayneri* (Rothschild), *Pyroderces* spp., and *Mythimna* sp. (Descamps, 1954; Doumbia & Bonzi, 1989; Ratnadass & Ajayi, 1995). In Ghana, *C. leucotreta* (Meyr.), *Lobesia aeolopa* (Meyr.) and *P. hemizopha* had been reported infesting sorghum heads (Agyen-Sampong, 1978). This study showed other caterpillars like the webworms, *N. sorghiella,* and *C. gnidiella* as important pests. These destroy developing grain and produce frass and webbing, resulting in quantitative and qualitative losses.

Though yet to be accurately assessed, there seems to be potential for biological control of panicle pests, especially mirid bugs. The controversy is over the status of earwigs in crop production. Though often abundant on sorghum panicles, some authors, including Nwanze (1985), consider them to be more of a nuisance to humans than the crop. Many farmers interviewed had similar perceptions about earwigs, with 66.7 and 100 per cent of farmers in Bolga and Bongo, respectively, describing them as nuisance organisms that bite them during harvesting. Krall, Youm & Kogo (1995) reported that nymphs and adult *F. senegalensis* feed avidly on millet spikelets, but damage inflicted on grain was negligible. In this study, they seemed to be more of beneficial organisms than pests, often observed feeding on head bugs.

Farmers recognized panicle feeders as pests on their crops, but did not usually think they caused economic damage; hence, they made no conscious efforts to control them. This is probably because most farmers grow local guinense-type sorghums, which are known to be less susceptible to panicle pests than the improved caudatum types (Doumbia & Bonzi, 1989; Sharma *et al.*, 1994). As the latter types of sorghum are introduced into the farming systems, the need is to sensitize farmers on the pest challenges likely to emerge and the possible actions that they can take to minimize crop damage. Similarly, farmers could not associate the chaffy heads observed on their fields with damage caused by midge. This phenomenon was usually blamed on drought, although the year under review experienced no significant drought throughout the growing season.

Yield loss studies consistently show that panicle insects are economic pests of sorghum that can cause up to 50 per cent yield losses in unprotected sorghum crops. The variety *Malisor 84-7* seemed to be less damaged by head insects than *Kapaala,* but none of these was superior to the local variety in pest resistance. There would be the need to explore more germplasm and varieties to identify sources of resistance, which can be combined with other options in evolving sustainable IPM systems for sorghum head bugs

and other panicle feeders.

Acknowledgement

The study was supported partly by the Competitive Agricultural Research Grant (CARG) Scheme, AgSSIP administered by the CSIR, Ghana for which the authors are grateful.

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