Research Article

Distribution of three weevil species in the various growth stages and residues of plantains (*Musa*spp) in Littoral Region of Cameroon

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ABSTRACT

Many people in the rural and semi-urban areas in the tropics depend on plantains and bananas as a staple food and as source of income. Bio-ecological studies such as quantifying insect pest numbers within-plants and with-in residues will help to reduce the amount of insecticides applied in plantations or farms. The distribution of three weevil species with respect to plantain growth stages and pre-/post-harvest residues was studied in a researcher-managed and a farmer-managed farm. Adult weevil species were counted from the following growth stages; suckers, pre-flowered, flowered, and bunched plants; as well as from these residues; desuckers, pseudo stem stumps, and cut pseudostems lying horizontally on the ground. Although *Cosmopolites sordidus* is widely reported as the most economically important insect on bananas/plantains, there were significantly more *Polytusmellerborgi* compared to *C. sordidus* and *Metamasiushemipterus* (very rare). In both farms, highest numbers of *C. sordidus* were found on pseudostemstumps as well as on bunched plants. In all the growth stages, numbers of the different weevil species were not significantly different in both farms. Also, for the residues, except for desuckers, all weevil species were similar in both farms. We proposed therefore that for any effective management of *C. sordidus*, application of management techniques that will significantly reduce adult numbers should focus on harvested stumps and bunched plants.

Key words: Coleoptera, Cucurlionidae, Insect, Pest management

RESUME

Beaucoup de gens dans les zones rurales et semi-urbaines dans les tropiques dépendent des plantains et des bananes comme aliment de base et source de revenu. Les études bio-écologiques, telles que la quantification du nombre d'insectes nuisibles dans les plantes et les résidus, contribueront à réduire la quantité d'insecticides appliqués dans les plantations ou les champs. La distribution de trois espèces de charançons par rapport aux stades de croissance des plantains et aux résidus pré / post-récolte a été étudiée dans une champ gérée par un chercheur et une champ exploitée par un agriculteur ou petit paysanne. Les espèces de charançon adulte et les invertébrés associés ont été comptés à partir des étapes de croissance suivantes: Rejets, plantes pré-fleuries, fleuries et en grappes; Ainsi que de ces résidus; des desqueuses, des souches récoltées et des pseudotroncs découpés couchés horizontalement sur le sol. Bien que *Cosmopolites sordidus* soit largement considéré comme l'insecte le plus important du point de vue économique sur les bananes / plantains, il y avait beaucoup plus de *Polytus mellerborgi* que *C. sordidus* et *Metamasius hemipterus* (très rare). Dans les deux champs, le plus grand nombre de *C. sordidus* a été trouvé sur les souches récoltées ainsi que sur les plantes avec des grappes. Dans tous les stades de croissance, le nombre de différentes espèces de charançons n'était pas significativement différent dans les deux champs. En outre, pour les résidus, à l'exception des déshuileurs, toutes les espèces de charançons étaient similaires dans les deux champs. Les invertébrés prédateurs potentiels trouvés étaient des fourmis, des perce-oreilles et des araignées. Nous avons donc proposé que, pour une gestion efficace de *C. sordidus*, l'application de techniques de gestion qui réduisent de façon significative le nombre d'adultes devrait se concentrer sur les souches récoltées et les plantes en grappes.

Mots clés: Coleoptera, Cucurlionidae, Insectes, Lutte anti-parasitaire

INTRODUCTION

Plantains and bananas are staple foods for many Cameroonians (Desdoight*et al.*, 2005; NgohNewilah, 2005). Generally, a typical banana and plantain plant consists of roots, corms, pseudostems (usually covered with dry old leaf sheaths), and the crown (leaves, fruits and flowers) (Speijer and De Waale, 1997). In Cameroon, the black banana corm borer weevil (*Cosmopolites sordidus*) has been mentioned as the main insect pest on banana/plantain production areas.This pest occur in 7 out of the 10 regions of Cameroon (Fogain, 1994; Fogain*et al*., 1998; Lescot, 1988; Tomekpe*et al*., 1999; Moulioum-Perfoura*et al*., 2002; Tomekpe&Fondi, 2008; Okolle*et al*., 2009). Other weevil species found on farms and plantations include the silky cane weevil (*Metamasiushemipterus*) and the small black species (*Polytusmellerborgi*).

In spite of all these reports in Cameroon, none has attempted to quantify the level of infestation or distribution in relation to banana/plantain growth stages or residues. According to Williamson *et al*., 2008, lack of such bioecological studies on pests is one of the major driving forces encouraging indiscriminate use of pesticides in most African smallholders' agroecosystems. Such studies are necessary because they will help to drastically reduce the amount of chemicals applied. Secondly, it will give preliminary insight on the behavioural evolution of the weevil species following different management techniques or agronomic practices in the farms. The objective of this research therefore was to quantify the infestation level of three weevil species in relation to phenological stages and pre-/post-harvest residues of plantains in two different production systems.

MATERIALS AND METHODS

Study site and production systems

The study was carried out in Njombe, Littoral Region of Cameroon. Njombe is about 80 km from Douala (Economic capital of Cameroon), and found between Latitude 4°35' North and longitude 9°39' East with a volcanic soil and an altitude of 80 meters above sea level (masl). The town has mean annual rainfall of 2086mm, mean monthly temperature that varies between 22.1°C and 32.2°C, while relative humidity varies between 32% and 100%.

The research was carried out in two plantain farms: (i) Researcher-managed farm found in the African Research Centre on Bananas and Plantains (CARBAP) in Njombe, and (ii) Farmer-managed farm also found in Njombe town. The researcher-managed system consisted mainly of 'Batard' cultivar (*Musa* AAB) and a few hybrids. Clean planting materials (plants from corm bits rapid multiplication technique) were used to establish the farm. The following agronomic and/or agricultural practices were carried out: Weeding (mechanically), desuckering (removal of excess suckers), fertilization (100-120g of N/plant/year, 35g of urea/plant, 50g of sulfate/plant/year, and 160g of KCl/plant/year), irrigation of 120mm water/plant/year, and use of pesticides (propiconazole at 100g/ha for sigatoka diseases, Cadusofos at 2g/ha (three times per year for nematodes), and Fipronil (Regent 5G®) at 30g/plant – twice per year for weevils). The borders of this farm consisted of banana plantations of Plantation Haut du Penja (PHP) Company, ornamental plants and weeds such as *Pennisetumpurpureum.*

The farmer-managed farm consisted mainly of 'Batard' and 'Big Ebangha' cultivars. It was established using traditional suckers from other fields. The farm also had food crops such as cocoyams, sweet potatoes, papaya and maize (a sort of mixed cropping). Agronomic practices

included manual weeding,desuckering, fertilization (100-120g urea/plant and 60g KCl/ plant only for the first cycle, as well as leaf prunning for control of sigatoka diseases.

Weevil distribution in relation to growth stages of plantains

To begin with, different growth stages in the farms were identified and categorized as follows: Suckers (SK), Pre-flowered plants (PF), Flowering plants (FP) and bunched plants (BP). SK were between O.5-1.5m in height and about 4 months old. PF were about 4-7 months of age and between 2-3.5m in height. The FPs were about 8-10 months old and between 3.5m to 4m in height.

In each farm, 100 plants of each growth stage or category were chosen and visually inspected randomly. Using a sharpened knife, old leaf sheaths on the pseudo stems were removed from the base up to about 1m. There was no destructive sampling since the farmer did not agree to that. Secondly, since the intention was not to address damage caused, there was no need for destructive sampling Three weevil species (*Cosmopolites sordidus* – entirely black in colour and between 9mm to 14mm in length, *M. hemipterus* – black in colour but with orange or yellow spots and between 9mm to 14mm in length, as well as *P. mellerborgi* that is black in colour and between 1.0cm to 1.1cm in length (excluding the rostrum) (Fogain, 1994; Padmanaban*et al*., 2001; Okolle*et al*., 2009). Without removing them, the weevils were counted in situ twice per month from August to October.

Weevil distribution in relation to residues

As with the growth stages, the major types of residues in the farm were identified and classified as follows: Desuckers (DS) (small plants removed from the parent plant or mat), cut pseudostems (CP) usually found on the soil after harvest, and harvested stumps (HS) usually 1-1.5m high. For each farm, 100 residues for each category were carefully inspected monthly from August to October. Using a sharp knife, old leaf sheaths were removed and the number of adult weevils of the different species counted. For DS and CP, a machete was used to split them longitudinally and then count adult weevils present and this was carried out monthly.

Data analyses

Mean numbers of weevil species for the different banana growth stages and residues in the two plantations or farms were calculated using descriptive statistical method by (Fowler *et al*., 1998). By using the Statdisk software (Mario *et al*., 2003), significant differences among the weevil species were first calculated using Analysis of Variance (ANOVA) and then subjected to Tukey's means separation test (Fowler *et al*., 1998). To find out whether the weevil species distribution for the different plantain growth stages and residues were significantly different in both farms, the means were subjected to a Z-test (Zar, 1999).

RESULTS

Distribution of weevil species in the researcher-managed farm

Generally, number of *C. sordidus* and *M. hemipterus* on growth stages were similar although it was significantly highly statistically different from the numbers of *P. mellerborgi* on PF and BP (**Table 1**). As for residues, *C. sordidus* and *P. mellerborgi* were similar but significantly different from numbers of *M. hemipterus* (**Table 1**). In all cases, there were highest numbers of *P. mellerborgi* on growth stages and residues (especially on HS) compared to *C. sordidus* and *P. mellerborgi* while *M. hemipterus* had no special preference. In addition, numbers of *C. sordidus* and *M. hemipterus* were similar in all growth stages while that of *P. mellerborgi* were more on PF and BP.

Table 1: Mean numbers (± SE) of adult weevil species on growth stages and residues of plantains in a researcher-managed farm in Njombe, Cameroon

Weevil Species	Growth stages				Residues		
	SK	PF	FP	BP	DS	CP	HS
Cosmo	1.14±0.08a	0.29±0.09a	0.12±0.04a	0.37±0.12a	0.03±0.02a	0.04±0.04a	0.33±0.08b
Metamas	0.00±0.00a	0.00±0.00a	0.03±0.03a	0.00±0.00a	0.00±0.00a	0.03±0.03a	0.08±0.04a
Polytus	0.65±0.17a	2.25±0.11b	0.43±0.13a	3.12±0.55b	0.09±0.03a	0.81±0.42a	1.85±0.44b

, Means with the same letters in a column are not significantly different at P = .05 (Tukey's Test). Cosmo = *Cosmopolites sordidus*, Metamas = *Metamasiushemipterus*, Polytus = *Polytusmellerborgi*.Sk = Suckers, PF = Pre-Flowered, FP = Flowered Plants, BP = Bunched Plants. DS = Desuckers, CP = Cut Pseudostems lying on the ground, HS = Harvested Stumps

Distribution of weevil species in the farmer-managed farm

From **Table 2** for the growth stages, weevils were present in all growth stages, except *M. hemipterus* that was present only on PF. Of all the species, *P. mellerborgi* had the highest numbers especially on PF and BP. In the residues, except P. mellerborgi absence in DS, weevils were present in all the residue types but highest on HS.

Table 2: Mean numbers (± SE) of adult weevil species on growth stages and residues in a farmer's-managed plantain farm in Njombe, Cameroon

Veevil Species	Growth stages				Residues		
	SK	PF	FP	BP	DS	CP	HS
Cosmo	0.11±0.04a	0.30±0.08a	0.33±0.06a	0.47±0.12b	0.07±0.02a	0.12±0.04a	0.68±0.12b
Metamas	0.00±0.00a	0.70±0.05a	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.27±0.13a	0.28±0.15a
Polytus	0.94±0.15a	7.10±0.6b	5.88±0.07b	7.25±0.06b	0.82±0.16a	0.58±0.15a	5.4±0.48b

Means with the same letters in a column are not significantly different at P = .05 (Tukey's Test). Cosmo = *Cosmopolites sordidus*, Metamas = *Metamasiushemipterus*, Polytus = *Polytusmellerborgi*.Sk = Suckers, PF = Pre-Flowered, FP = Flowered Plants, BP = Bunched Plants. DS = Desuckers, CP = Cut Pseudostems lying on the ground, HS = Harvested Stumps

Comparing infestation of weevil species in farmers and researcher-managed farms

In all the growth stages, numbers of the different weevil species were not significantly different in both farms (research-managed and farmer-managed) (**Table 3a**). However, for the residues (**Table 3b**), with the exception of DS where *P. mellerborgi* was significantly different, all weevil species were similar in both farms.

Table 3a: Comparison of mean numbers (± SE) of adult weevil species from different growth stages of plantains in a researcher-managed (RM) and farmer-managed (FM) farm

Weevil Species	Growth Stages							
	Suckers (SK)		Pre-Flowered (PF)		Flowered Plant (FP)		Bunched Plant (BP)	
	RM	FM	RM	FM	RM	FM	RM	FM
Cosmo	1.14±0.08a	0.11±0.04a	0.29±0.09a	0.30±0.08a	0.12±0.04a	0.33±0.06a	0.37±0.12a	0.47±0.12
Metamas	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.07±0.05a	0.03±0.03a	0.03±0.00a	0.00±0.00a	0.00±0.00
Polytus	0.65±0.17a	0.94±0.15a	2.25±0.11a	7.10±0.67a	0.43±0.13a	5.88±0.07a	2.12±0.55a	7.25±0.06

Means with the same letters in a row are not significantly different (Z-Test, Critical Z-value = 1.96). Cosmo = *Cosmopolites sordidus*, Metamas = *Metamasiushemipterus*, Polytus = *Polytusmellerborgi.*

Table 3b: Comparison of mean numbers (± SE) of adult weevil species from different residues of plantains in a researcher-managed (RM) and farmer-managed (FM) farm

Weevil Species	Residues					
	Desuckers (DS)		Cut Pseudostem (CP)		Harvested Storm (HS)	
	RM	FM	RM	FM	RM	FM
Cosmo	0.03±0.02a	0.07±0.02a	0.04±0.04a	0.12±0.04a	0.33±0.08a	0.68±0.12a
Metamas	0.00±0.00a	0.00±0.00a	0.03±0.03a	0.27±0.13a	0.08±0.04a	0.28±0.15a
Polytus	0.09±0.03a	0.82±0.16b	0.81±0.42a	0.58±0.15a	1.85±0.44a	5.4±0.48a

Means with the same letters in a row are not significantly different (Z-Test, Critical Z-value = 1.96). Cosmo = *Cosmopolites sordidus*, Metamas = *Metamasiushemipterus*, Polytus = *Polytusmellerborgi*

What of the damage caused by the weevils? Damage is more important than mere numbers of weevils. As *Polytusmellerborgi populations were very high in the plantains, was this also tanslatedinto high damage cause by this species? (unfortunately damage assessment was not considered for this study.*

DISCUSSION

All the three weevil species recorded in this study have been previously reported on bananas and plantains in Cameroon (Fogain, 1994; Fogain*et al*., 1998; Ysenbrandt*et al*., 2000, Okolle*et al*., 2009). However, according to Ysenbrandt*et al*. (2000), and based on pseudostem trapping results, only *P. mellerborgi* and *C. sordidus* were recorded; and no *M. hemipterus* were found. This is somehow similar to the present study where although all three weevil species were recorded, *P. mellerborgi* and *C. sordidus* were more common while *M. hemipterus* was very rare. Since *M. hemipterus* was rarely found on residues and growth stages, it may imply that plantains are not a major host plant for the weevils.

In both farms, highest numbers of *C. sordidus* were on HS residues and BP growth stages. On East African highland bananas, Gold *et al*. (1998) reported that *C. sordidus*adult density was highest on flowered plants although total weevil numbers were associated with preflowered plants and harvested stumps. These authors also reported 92% oviposition in standing residues (HS) and that toppled plants and harvest pseudo-stems lying on the ground were favored breeding sites. However, contrary to our study, Masanza*et al*., (2005a) reported more adult weevils on prostrate than on harvested stumps although oviposition was similar for both residues. Ittyeipe, (1996) found out that more eggs are laid on corms to which more adult borers are attracted. This suggests that for effective management of the adult *C. sordidus* in small-scale farms and plantations, HS residues and BP growth stages should be targeted for chemical control, application of entomopathogens and placing of disc-on-stump or disc-corm traps.

In addition, removal of HS and CP residues from the farm to a spot where they can be decomposed or chopped into smaller pieces will help to decrease population of adult weevils. Field sanitation especially the removal and/or destruction of residues have been widely mentioned as very useful for sustainable management of weevils in banana farms (Seshu Reddy *et al*., 1998; Karamura&Sikora, 1998; Masanza*et al*., 2005b, Tiwari*et al*., 2006). While some scientists think that residues should not be removed because they attract ovipositing adults and divert their attention from living plants, others think that residues should not be allowed because when they rot, the young emerging weevils will have opportunity to attack more plants. Treverrow (2003) mentioned that extreme care should be taken if harvested stumps are removed because this might affect suckers depending on the stumps for nutrients.

As for growth stages, removal of old leaf sheaths from BP and/or spraying them with reduce amount of insecticide will also help reduce the population of adults especially females that lay eggs. According to Gold and Messiaen (2000), cut corms or bulbs or pseudostems attract more adult weevils but according to Gold *et al*. (1998), more adult weevils are usually associated with residues especially HS. All these show that HS is an important source of infestation to nearby suckers or plants sharing the same mother corm. To protect such plants, insecticidal treatments should be applied around these HSresidues or disc-on-stump/disc-corm traps treated with insecticides or entomopathogens should be applied on modified traps constructed on these harvested stumps.

In conclusion, all three weevil species are found on plantains cultivated in a researcher-managed farm and a farmer-managed farm in Njombe, Cameroon. Although *C. sordidus* is widely considered as the most economically important of all the weevils on bananas/plantains, there are now more *P. mellerborgi*. Residues especially harvested stumps (HS) serve as important refuge/ breeding site for adult *C. sordidus*. Does *P. mellerborgi cause as high damage on plantains as C. sordidus? High numbers without commensurate damage are inconsequential. C. sordidus is considered the most economically important weevil species on plantains because of the severe damage it causes on this crop. (unfortunately damage assessment was not considered for this study)-*

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