American Open Journal of Agricultural Research
Vol. 1, No. 1, May 2013, PP: 01 - 07
Available online at http://acascipub.com/Journals.php

Research article

Degree of infestation of transplanted sorghum [*Sorghum bicolor* (L) Moench] by Lepidoptera stems borers and their biodiversity in Diamaré (Maroua, Cameroon)

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Abstract

In order to assess the degrees of infestation in fields of transplanted sorghum in Diamaré-Maroua and to know the biological diversity and abundance of different species of borers that attack sorghum plants during the off-season, sampling were conducted in farmers' fields from 12 December 2011 to 6 January 2012 and from January 3 to 28, 2012 in five locations. Non-destructive and destructive methods were used to measure the infestation parameters (holes on the stems, the presence of caterpillars and leaf with characteristics holes). Tested at a significance level of 5% with the Student's T-test, the mean levels of these parameters of infestation were almost all different ($p < 0, 05$) between localities and years. With an infection rate of 15.05% for the 2010-2011 season and 13.9% for the 2011-2012, the locality of Balaza was the most infested with Lepidopteran stem borers; and specie *Sesamia cretica* (Lederer) (Lepidoptera: Noctuidae) was the most abundant and accounted for over 60% of caterpillars collected.

Keywords: *Sesamia cretica*, Diamaré-Maroua, infestation level, transplanted Sorghum

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Introduction

Sorghum [*Sorghum bicolor* (L) Moench] is a major cereal produced worldwide for its seeds, its sugar content and its feed quality (Liu et al, 2009). It requires little water; therefore it is best suited in Africa in the arid zones with rainfall deficit (House, 1995). The transplanted sorghum occupies an important place in the Lake Chad Basin (Carsky et al., 2002) which includes northern Cameroon, northern Nigeria and West of Chad. In Cameroon, where it bears the name of *Muskuwari*, its production is estimated at more than 40% of cereal production for 2008-2009 crop saison (MINAGRI, 2010). In the Far North in general and in the Department of Diamaré in particular, it is the main cereal consumed as food and it is produced at the end of the rainy season on Vertisols, unusable during the rainy season. This off-season culture has seen a marked increase in plantings in the last decade with the advent of herbicides which reduced the drudgery (Mathieu, 2005) and allowed an increase in sorghum production necessary to offset the poor production of rainy season sorghum. With the demand for ever increasing, corollary of population growth and the use of sorghum for the production of biofuels, considerable efforts are required for increase production and conservation (Guo et al., 2011) around the world. Therefore ensure its availability requires that, in addition to the increase in the planted area, considerable efforts in securing the crops against pests whose damage can go up to the total loss of production and in the improvement of cultivation techniques . Although likely to escape attacks by pests and diseases compared to the rainy sorghum (Tabo et al., 2002), *Muskuwari* is attacked by pests including Lepidoptera stem borers. In situations of severe attack, these organisms can cause a considerable reduction of the photosynthetic area of the plants through their food intake and thus adversely affect production. Some species of Lepidoptera stem borers have larvae that penetrate after hatching inside the stem where they grow, while realizing galleries that prevent the smooth flow of sap and make plants susceptible to falling. Damage of Lepidoptera drillers vary seasonally and with cultural practices, and can go up to 60% loss of seed production (Olaye et al. 2005a). These pests, more recurring in the transplanted sorghum in Diamaré have different eating habits, larvae of *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae), and *Eldana saccharina* Walker (Lepidoptera: Pyralidae), for example do not feed on the leaves and penetrate almost immediately after hatching in the stems where they realize galleries while those of *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae) and *Chilo partellus* (Swinhoe) (exotic to Africa) migrate after hatching at the top of the plant to feed then realizing characteristics fenestrations and cause dead hearts (Mailafia & Robe, 2012). The losses are then the result of damage caused by this guild at a moment and stages of development of the plant and whose abundance and diversity are to be determined. It was found that the incident of Lepidoptera stem borers on transplanted sorghum varies depending on culture techniques (transplanting date and planting technique, variety of transplanted sorghum) and climatic factors such as temperature and relative humidity (Mailafia & Robe, 2012). Mathieu Bertrand et *al*. (2006) in the context of trying to fight with plant extract in Diamaré have identified the species *S. cretica* Led. (Lepidoptera: Noctuidae) as the most wide spread species of borers and damages were more than 40% of the production. Data on the degree of infestation in farmers' fields, the diversity and abundance of these pests are still sparse. This work, which is a contribution to an integrated management of Lepidoptera stem borers on transplanted sorghum in Diamaré (Maroua, Cameroon), aims to assess the level of infestation of transplanted sorghum plants in farmers' fields, to assess the abundance and biodiversity of these pests through field investigations.

Materials and methods

Sampling was conducted in farmers' fields under natural infestations from 12 December 2010 to 06 January 2011 and January from 3 to 28, 2012 in Diamaré, one of the six Departments of the Far North of Cameroon Region (see figure) which belongs to sahelian zone with two distinct seasons. The dry season lasts approximately 6 months from November to April, 4 months with no rainfall and very low humidity. During this period, December to April, the relative humidity of air is lowered to less than 30% and the average temperature often exceeds 30° C. The rainy season extends from May to October, with rainfall varying with latitude and proximity to the Mandara Mountains (Mathieu, 2003). Fields sampled (see figure), distant at least 1km away from each other, were selected according to the criteria of accessibility and the phenological stage of the plant (maturation stage).

All fields of Diamare area are considered as a homogeneous, they were then divided into five blocks, in each block one locality is chosen and an average of 11 fields is sampled.

A total of 54 fields were sampled each year; each field selected is divided into four plots and in each plot, a square (10 m x 10 m) is delimited with the string calibrated before. In each plot, infestation rate (rif = Pif/T) is estimated as the number of plants showing signs of attack (leaves with holes, holes on the rods) (Pif) on the total number of plants (T). The average infestation rate of the field being the average rate of the plots and the infestation rate of each locality (Rif) is calculated as the sum of infested plants on the total number of plants sampled in this locality. In fields where the owners are present, an average of 20 infested plants are purchase and cut low to the ground and dissected, the holes on the stem are counted and the larvae found are preserved in alcohol at 70° then subsequently identified to the rank of species through the key of identification of Pascal Moyal & Tran Maurice (1989), Maurice Tran (1981) and that of Polaszet and Delvare (2000). A total of 9364 plants were examined and 520 plants dissected per year. Data were submitted to Student's T-Test to assess differences in infection rates between localities and between years using the software R (Roasted Marshmallows, 2012).

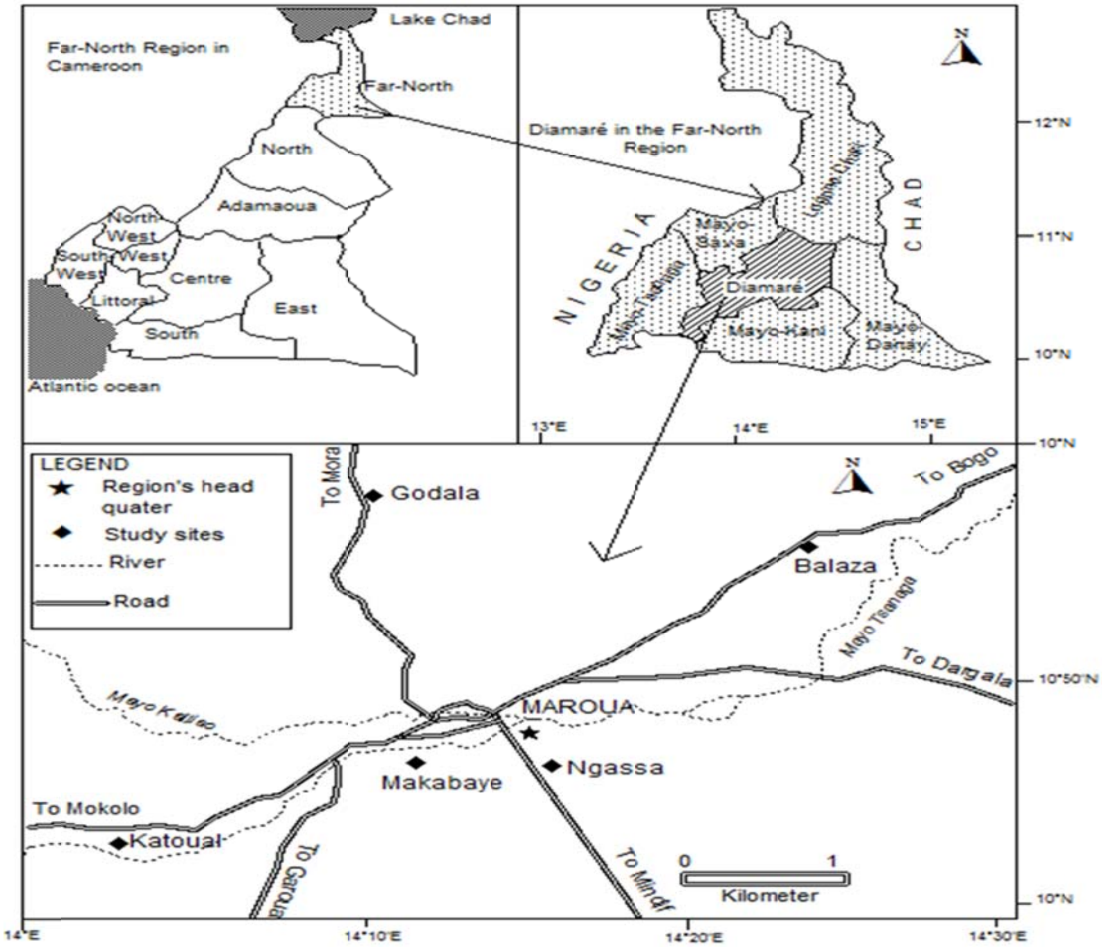

Figure: Location of sampling sites in the Diamaré (Maroua, Cameroon)

Results

The stem borer moths cause damage during their larval development and the signs of infestation are most obvious the characteristic holes on the leaves and stems. On all fields sampled in 2011 and 2012, a total of 18738 plants were examined and 1950 plants showed signs of infection, which gives an overall rate of infection of 9.34% in 2011 and 8.24% in 2012. Degrees of infestation observed vary from one locality to another, the most attacked fields are those of Balaza with 15.05% and 13.9% respectively in 2011, 2012 while the Less attacked are those of Godola with respectively in 2011 and 2012 the rates of 7.28% and 5.85%. There is a difference between the infestations of fields for sampled localities during the two years (table 1).

Table 1: infestation levels of transplanted sorghum plants in Diamaré (Maroua-Cameroon) for 2011 and 2012 cropping season.

		2011		2012	
Localities	**Examined plants**	**Infested plants**	**Infestation rates**	**Infested plants**	**Infestation rate**
Ngassa	1900	141	7,42 %	115	6,05 %
Balaza	2100	316	**15,05** %	292	**13,9** %

Godola	1950	142	**7,28 %**	114	**5,85 %**
Katoual	1900	165	8,68 %	154	8,11 %
Makabaye	1514	111	7,33 %	97	6,41 %
Total	**9364**	**875**	**9,34** %	**772**	**8,24 %**

Table 2: Comparison of average (*means* ± ES) studied parameters in different fields of transplanted sorghum in Diamaré (Maroua, Cameroon)

				Species of caterpillard	
yeras	**Localities**	**holes**	**Caterpillards**	***Sesmia cretica***	***Sesamia poephaga***
	Ngassa	5,31 ± 0,58 ^{a}	2,50 ± 0,47 ^{a}	1,46 ± 0,26 ^{a}	0,98 ± 0,26 ^{a}
	Balaza	6,12 ± 0,63 ^{ab}	1,19 ± 0,34 ^{b}	0,73 ± 0,22 ^{b}	0,46 ± 0,17 ^{b}
2011	Godola	2,81 ± 0,44 ^{c}	1,35 ± 0,26 ^{cb}	0,90 ± 0,21 ^{abc}	0,44 ± 0,09 ^{abc}
	Katoual	4,40 ± 0,44 ^{ad}	0,87 ± 0,19 ^{bcd}	0,65 ± 0,14 ^{cbd}	0,21 ± 0,06 ^{bd}
	Makabaye	3,29 ± 0,33 ^{e}	1,10 ± 0,22 ^{cbd}	0,75 ± 0,17 ^{cbd}	0,33 ± 0,08 ^{cbd}
	Ngassa	4,73 ± 0,45 ^{a}	2,36 ± 0,44 ^{a}	1,50 ± 0,27 ^{a}	0,80 ± 0,23 ^{a}
2012	Balaza	5,81 ± 0,54 ^{b}	0,92 ± 0,28 ^{b}	0,48 ± 0,15 ^{b}	0,33 ± 0,12 ^{b}
	Godola	2,38 ± 039 ^{c}	1,40 ± 0,27 ^{cb}	0,92 ± 0,20 ^{acb}	0,46 ± 0,08 ^{acb}
	Katoual	4,21 ± 0,43 ^{ad}	0,90 ± 0,19 ^{cbd}	0,75 ± 0,16 ^{cbd}	0,21 ± 0,06 ^{bd}
	Makabaye	3,06 ± 0,33 ^{e}	1;11 ± 0,21 ^{cbd}	0,73 ± 00 ^{cbd}	0,33 ± 0,08 ^{cbd}

Within each column, means followed by the same letters are not significantly different from each other at $P < 0,05$ following the T-test of Student

Table 3: relative abundance of different species of caterpillars found in farmers' fields in Diamaré (Maroua, Cameroon)

		Sesamia cretica		***Sesamia poephaga***			
Years	**Localities**	**Total**	**Pourcentage**	**Total**	**Pourcentage**	**Unidentified caterpillards**	**Total of caterpillard**
	Ngassa	76	58,46 **%**	51	39,23 **%**	3	130
	Balaza	38	61,29 **%**	24	38,71 **%**	0	62
	Godola	47	67,14 **%**	23	32,86 **%**	0	70
2011	Katoual	34	75,56 **%**	11	24,44 **%**	0	45
	Makabaye	39	68,42 **%**	17	29,82 **%**	1	57
	Total	**234**	**64,29 %**	**126**	**34,62 %**	**4**	**364**
	Ngassa	84	63,64 **%**	45	34,09 **%**	3	132
	Balaza	23	52,27 **%**	16	36,36 **%**	5	44
2012	Godola	4	5,48 **%**	24	32,88 **%**	45	73
	Katoual	36	76,60 **%**	11	23,40 **%**	0	47

Makabaye	38	65,52 **%**	17	29,31 **%**	3	58
Total	**185**	**52,26 %**	**113**	**31,92 %**	**56**	**354**

The maximum number of larvae harvested after dissection of plants is 15 larvae per plant at Ngassa, while the maximum number of holes was 27 holes per plant at Balaza. Comparison of means using the Student's T-test at a significance level of 5%, gave a significant difference ($p < 0.05$) between the number of caterpillar between Ngassa and other localities (Table 2), which indicate that transplanted sorghum plants at Ngassa is most infested by borers. The genus *Sesamia* seem to be the only represented and the species *S. cretica* the most dominant and accounted for over 64% of caterpillars collected in 2011 and over 54% in 2012 (Table 3). Compared between years, the degrees of infestation of plants are all different from one year to the next for all localities; the number of caterpillars and the relative abundance of different species of borers encountered are any differences for all communities between 2011 and 2012.

Discussion

The development cycle of Lepidoptera includes the egg, the larva, the pupa and the imago; only the larvae are phytophagous and attack plants in the vegetative phase. Borer larvae may, in the absence of host crops, grow on wild hosts and complete their life cycle or inter diapause until the next season and cause infestations of crops upon the resumption of agricultural activities. The *Muskuwari* begins its cycle at the time of harvest of sorghum wet, so it is likely that borer's females lay eggs on transplanted sorghum plants which will develop generations (Mathieu et al., 2006). *Sesamia cretica* (Lederer) (Lepidoptera: Noctuidae) and *S. poephaga* Tams & Bowden, two species of borers were harvested on transplanted sorghum were also found on wet sorghum in Chad (Djimadoumngar, 2001; Ratnadass, 2003) and Egypt (Ezzeldin et al. 2009). Our observations on all fields visited confirm the status of major pests of transplanted sorghum in Diamaré of these two species of the genus *Sesamia* and tend to confirm the theory of migration of these pests from wet sorghum to transplanted sorghum; neighboring fields of wet sorghum are more infested than fields located in more depth these green bands that are fields of sorghum against season. However, infection rates obtained in different localities sampled may have been influenced by the nature of the plant material. The *Muskuwari* has several ecotypes some of which are more or less resistant to pests; the *Safraari* ecotype for example, highly valued for its nutritional qualities of succulent stems and seeds used as fodder for cattle nutrition, is strongly attacked by stem borers than *Madjeeri* ecotype (Mathieu et al., 2006) The unavailability of seedlings during transplanting period, due to the uncertainty of the end of the rains that marked the effective start transplanting (Bousquet and Legros, 2002), force farmers to use any variety to take advantage of soil moisture. Different rates of infestation of plants between localities could be a consequence of the varietal diversity of *Muskuwari*. Furthermore it is known that more stalks are large, they attract more drillers (Feller and Mathis 1997, Cunningham and Floyd 2006; Tatiana Cornelissen et al., 2008), and the varied nature of soils in the Diamaré (Boutrais, 1984 Seiny Boukar, 1990) may contribute to moderate or facilitate the attack of pests. The capacity of the plant to resist or tolerate the presence of pests is related to the vigor of the plant, the physical and biological properties of the soil. Soils with a high content of organic matter have high fertility and have a complex of nutrients and organisms that prevent infection (Miguel and Clara, 2003) also cultural practices that cause imbalances in the ground play for lower resistance to pests (Magdoff and van Es, 2000). Thus, cultural practices (soil preparation, transplanting) in addition to the quality of soil and variety of the plant induce different infestation level. Rainfall, very crucial condition for the good production of sorghum during the rainy season intervene in the process of charging water of soil useful for the development of transplanted sorghum during the off-season, may have less impact in the development of such a pest.

Conclusion

Although the variable damage to the transplanted sorghum from one locality to another in the Diamaré seems the mere fact of stem borer moths, *Sesamia cretica* (Lederer) (Lepidoptera: Noctuidae) and *Sesmia poephaga*, other species such as *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae), *Coniesta infusalis* (Hampson) (Lepidoptera: Pyralidae) and *Eldana saccharina*, harvested on sorghum wet in Nigeria and elsewhere (Ethiopia, Chad), are likely to be presents. Further studies such as the study of the dynamics of populations of these pests, the importance of culture techniques involved in production of transplanted sorghum and the influence of soil on the infestations, could help better in developing strategies to fight against these insects.

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