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Abundance and biological diversity of Lepidopteran stems borers infesting the transplanted sorghum (*Sorgho bicolor* L. Moench) in the Far-North Region Cameroon.

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Abstract

Sorghum (*Sorghum bicolor* L. Moench) is the first cereal consumed in tropical regions with a deficit of rainfall. The off season cultivars, transplanted during the dry season on Vertisols, constitute an additional production to solve the problem food availability. Unfortunately, production efforts are hampered by stem borers which jeopardize its availability; and the only way to protect against drillers is chemical. This work, conducted in peasant fields and in experimental stations, aimed together knowledge about the abundance and biodiversity of Lepidoptera stem borers associated with transplanted sorghums in the Far-North of Cameroon for their ecological management. Thanks to the destructive method which consists on splitting of the infested stems and harvesting borer's caterpillars, driller populations have been estimated. The collected data was then been submitted for analysis using the XLSTAT software for the characterization of the populations. Field under natural infestations revealed the presence of three species, *Sesamia calamistis*, *S. poephaga* and *S. cretica*. S. *cretica* with an average numbers ranging from 0.75 to 2.41 caterpillars was still the most abundant species on all varieties tested and in all localities. The role of the environment, cultivation techniques and varietal resistance in the development of Lepidoptera stem borer's populations was thus highlighted. Since transplanted sorghum plays a key role in the alimentation of the population in the Far-Nord, the varietal screening for resistance to these pests would therefore be welcome, as pest management via varietal resistance is an ecological means accessible to all producers.

Keywords: Lepidopteran drillers, *Sesamia cretica*, off season sorghum, Far-North Cameroon

I. Introduction

Phytophagia is widespread in major Insect Orders, but among the Orders, Lepidoptera include a very high proportion of phytophagous species. This phytophagia affects many angiosperms.Lepidoptera are therefore a key element of biocenosis and it is not surprising that they frequently interfere with humans as pests.

They therefore constitute a major constraint to the production of cereals in the world and in particular in Africa for small producers of low economic levels (Mohamed, 2006). Sorghum (*Sorghum bicolor* L. Moench), the first cereal consumed in tropical regions with a deficit of rainfall, is under attack by stem borers, which jeopardize its availability. Transplanted during the dry season on Vertisols, its production solves the problem of food insecurity. Unfortunately, production efforts are hampered by stem borers that cause losses of up to 35% of seed production on the *Safra* variety (Mathieu *et al*. 2006). The only way to reduce damages is unfortunately chemical. The search for accessible and ecological means to reduce losses due to these pests is therefore essential. This work is then a contribution to ecological management of these pests through knowledge of the variability of their abundance and biological diversity according to different localities and locals varieties of *Muskuwari* (transplanted sorghum) produced in the Far North region of Cameroon.

II. Materials and Methods

II-1 Experimental devices

The experimentation was done from 2011 to 2013 in the Diamare Department (Figure I), the main production area for the transplanted sorghum (*Muskuwari*). All farms under natural infestation were then considered as homogeneous block and divided into five largessub-blocks and in each sub-block a locality is chosen according to its accessibility. An average of 11farmer's fields per locality is chosen and sampled in 2011 and 2012. In 2012 and 2013, 10 localssorghum varieties (*Mandouéri*, *Bourgouri*, *Soukatari*, *Madjéri noncrossé*, *Safra non crossé*, *Sulkéri*,*Adjagamari*, *Safracrossé*, *Tchangalari*, *Madjéricrossé*) were transplanted atNgassa, one of the five chosen localities, in a Completely Randomized Block (BCR) design with three repetitions.Each variety is represented in a block by three rows of 45 m long. The blocks are separated from each other by a distance of 2 meters. Plants of 40 days old are paired in holes of 8 cm deep previously filled with waterand are separated on the line by a distance of 90 cm and a meter between the lines. The whole of this design is delimited by a border of two lines on which no experimentation is conducted.

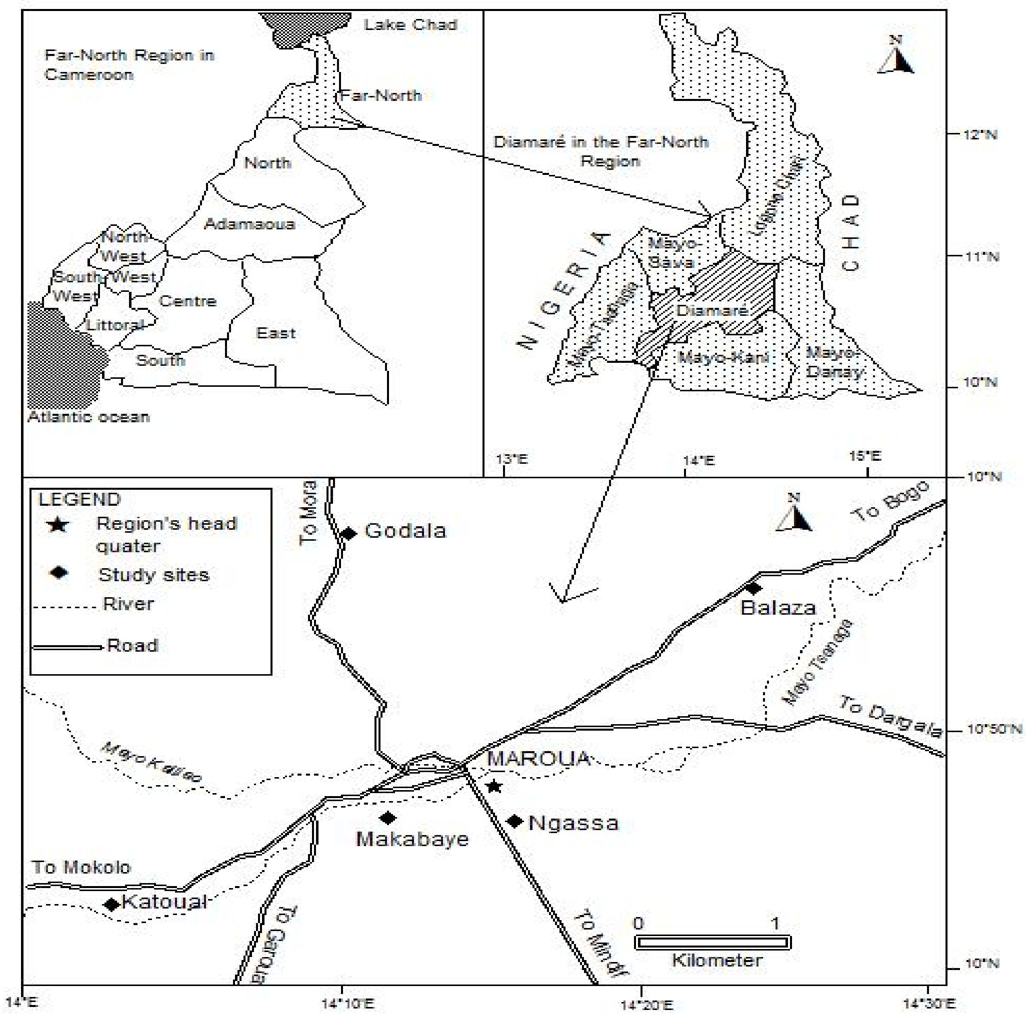

Figure I: Geographical location of the different sampling sites

II-2 Sampling

Each selected field is divided into four plots and in each plot, a Quadra of 10 m^2 is delimited by means of a previously calibrated string and in the fields where the owners are present, an average of 20 infested plants were randomly selected (five per Quadra)and cut to the ground level and dissected by splitting stems longitudinally.In the experimental plot, for each variety and in each repetition, uninfested plants are separated from the infested plants whose stems are dissected as before. The larvae of the drillers found in each stem are counted and identified by the means of the identification keys of Pascal Moyal and Maurice Tran (1989), Maurice Tran (1981) and Polaszet and Delvare (2000). Those not identifiable in the field are kept in alcohol (70 °) and subsequently identified

II-3 Data processing

The datas were entered and ranked first using the Excel spreadsheet and then analyzed using XLSTAT Software (Version 2013.5.0).

III. Results and Discussion

Lepidoptera borersare holometabolous Insects. Adults are nectarivorous while larvae (caterpillars) are first phytophagous and then xylophagous. In your study, the borer's entomofauna is evaluated through the larvae, authors of damages on transplanted sorghum. Table I gives the result. It shows a harvest of 728 caterpillars in the farmer's fields in 2011, of which more than 64% (234caterpillars)were identified as of the *S. cretica* species. The others species, all belonging to the genus of *Sesamia* (*S. poephaga*and *S. calamistis*), have represented respectively 34.62% and 1.09% of harvest. In 2012 all harvested caterpillars (652 caterpillars) were still of the genus *Sesamia*; 185 caterpillars were *S. cretica*, more than 52% of the caterpillars harvested. The *S.poephaga* and *S.calamistis* species accounted for 31.92% and 15.82% of caterpillars respectively. *S. cretica* (Lederer) with an average of 1.46 and 1.50 respectively in 2011 and 2012 is still the most abundant in the fields of all sampled localities. There is also the same dominance of this specie in the experimental field.

Table I: Relative abundance of different species found in farmer's fields.

Years		*Sesamia cretica*(Lederer)			*Sesamia poephaga*			*Sesaamia calamistis*		
	Localités	Mean ± Standard deviation	Total	%	Mean ± Standard deviation	Total	%	Mean ± Standard deviation	Total	%
2011	Ngassa	**1,46±1,88**	76	58,46	0,79±1,49	51	39,23	0,19±0,56	130	2, 3
	Balaza	0,73±1,60	38	61,29	0,38±1,07	24	38,71	0,10±0,36	62	0
	Godola	0,90±1,52	47	67,14	0,42±0,61	23	32,86	0,02±0,14	70	0
	Katoual	0,65±1,03	34	75,56	0,21±0,46	11	24,44	-	45	0
	Makabaye	0,75±1,22	39	68,42	0,31±0,58	17	29,82	0,02±0,14	57	1,76
	Total général		**234**	**64,29**		**126**	**34,62**		**364**	**1,09**
2012	Ngassa	**1,50±1,97**	84	63,64	0,83±1,71	45	34,09	0,02±0,14	132	2,27
	Balaza	0,46±1,04	23	52,27	0,29±0,72	16	36,36	0,02±0,14	44	11,34
	Godola	0,92±1,47	4	5,48	0,44±0,61	24	32,88	0,02±0,14	73	61,64
	Katoual	0,75±1,15	36	76,60	0,21±0,46	11	23,40	-	47	0
	Makabaye	0,79±1,07	38	65,52	0,27±0,4	17	29,31	0,06±0,24	58	5,17
	total amount		**185**	**52,26**		**113**	**31,92**		**354**	**15,82**

Table II: Relative abundance of different caterpillars species encountered in the experimental field.

Statistics	*S. cretica* Years 2012/2013	*S. poephaga* Years 2012/2013	*S. calamistis* Years 2012/2013	Total amount Years 2012/2013
Observations	900	900	900	**900**
Minimum	0	0	0	**0**
Maximum	12/9	1,00	2,00	**13**
Total	1500/1081	95/101	65/48	**1657/1230**
Averages	1,67/1,20	0,11/0,11	0,07/0,05	**1,85/1,37**
Variance (n)	4,33 /1,95	0,09/0,10	0,07/0,05	**4,80/3,35**
standard deviation(n)	2,08/1,72	0,31/0,32	0,26/0,22	**2,19/1,83**
Percentage (%)	**90,53 / 87,89**	**5,73 / 8,21**	**3,92 / 3,90**	**1,00**

Table III shows that mean values of caterpillars are ranging from 0.05 caterpillars to 1.67 caterpillarsand *Sesamiacretica* with 90.53% caterpillars in 2012 and 87.89% caterpillars in 2013 is the most abundant on both years. In addition, Tables I and II show that the standard deviations are always higher than the averages both in the experimental plots and farmers' fields.In fact, transplanted sorghum begins its cycle when sorghumsof rainyseason are harvested and the infestations of transplanted farmsfrom rainyseason farms are non-homogenous. The obvious signs of infestation are the characteristic fenestrations of the leaves and the holes on the stems. At the time of sampling, the dissected stems may no longer harbor larvae because they have already completed their cycle or could not survive in defense of the plant, hence the very large dispersion (standard deviations always higher than average) found within the populations. The off-season agricultural landscape and farming techniques play a role in the distribution of pest populations.Mixing varieties of different sensitivities has negative effects on pests (Jeger 1999). This aspect is illustrated in *Magnaporthegrisea* (a pathogenic fungus of rice) whose propagation has been significantly limited in a mixed culture of two varieties of rice of different sensitivity (Zhu *et al*., 2000). Insect pests and their plants have coexisted for millions of years. Pests tend to select specific plants or a particular phenology of their host plant to optimize their food intake or guarantee their reproductive success; which triggers defensive reactions (Van Emden, 1978) that can lead to the death of the pest or its reproductive failure.Thus, the number of caterpillars per infested plant is a good indicator of pest resistance. The ten traditional varieties of transplanted sorghum showed different populations levels of caterpillars, thus demonstrating variations in the varietal sensitivity of transplanted sorghum to Lepidopteran stem borers.*S. cretica*, with an averages number of caterpillers ranging from 0.75 on the VA10 variety to 2.41 on the VA4 variety is always more abundant on all varieties tested. Table III gives the distribution of caterpillars according to the different varieties of local transplanted sorghum. Transplanted fields are rarely monovarietal, which helps to limit the propagation of these pests. Temperature is also known to play a major role in the development of pests and their natural enemies (Huffaker*et al.* 1999). It determines the limits of biological activities of Arthropods in general and Insects in particular.

Table III: Abundance of caterpillars on different varieties of transplanted sorghum in Far North Cameroon.

	Sorghum varieties	N.o	Min	Max	Total	Mean	Variance (n)	Standard deviation
S. cretica	*Mandouéri*	180	0	8	218	1,21	2,62	1,62
	Madjeri crossé	180	0	5	132	0,73	1,15	1,07
	Bourgouri	180	0	7	162	0,90	1,77	1,33
	Soukatari	180	0	12	157	0,87	2,13	1,46
	Madjeri non crossé	180	0	9	433	2,41	5,39	2,32
	Safra non crossé	180	0	12	171	0,95	3,16	1,78
	Soulkeri	180	0	8	348	1,93	3,77	1,94
	Adjagamari	180	0	9	321	1,78	3,94	1,98
	Safra crossé	180	0	12	364	2,02	5,69	2,39
	Tchangalari	180	0	12	275	1,53	4,29	2,07
S. poephaga	*Mandouéri*	180	0	1	26	0,14	0,12	0,35
	Madjeri crossé	180	0	1	21	0,12	0,10	0,32
	Bourgouri	180	0	1	10	0,06	0,05	0,23
	Soukatari	180	0	1	16	0,09	0,08	0,28
	Madjeri non crossé	180	0	1	19	0,11	0,09	0,31
	Safra non crossé	180	0	1	12	0,07	0,06	0,25
	Soulkeri	180	0	1	14	0,08	0,07	0,27
	Adjagamari	180	0	2	26	0,14	0,13	0,37
	Safra crossé	180	0	1	38	0,21	0,17	0,41
	Tchangalari	180	0	2	14	0,08	0,08	0,29
S. calamistis	*Mandouéri*	180	0	1	10	0,06	0,05	0,23
	Madjeri crossé	180	0	1	6	0,03	0,03	0,18
	Bourgouri	180	0	1	6	0,03	0,03	0,18
	Soukatari	180	0	2	16	0,09	0,09	0,30
	Madjeri non crossé	180	0	1	6	0,03	0,03	0,18
	Safra non crossé	180	0	1	17	0,09	0,09	0,29
	Soulkeri	180	0	1	15	0,08	0,08	0,28
	Adjagamari	180	0	1	16	0,09	0,08	0,28
	Safra crossé	180	0	1	12	0,07	0,06	0,25
	Tchangalari	180	0	1	9	0,05	0,05	0,22
Total	*Mandouéri*	180	0	9	254	1,41	3,14	1,77
	Madjeri crossé	180	0	5	159	0,88	1,36	1,17
	Bourgouri	180	0	7	178	0,99	1,88	1,37
	Soukatari	180	0	12	186	1,06	2,60	1,61
	Madjeri non crossé	180	0	9	458	2,54	5,63	2,37
	Safra non crossé	180	0	12	200	1,11	3,42	1,85
	Soulkeri	180	0	8	377	2,09	4,00	2,00
	Adjagamari	180	0	9	363	2,02	4,75	2,18
	Safra crossé	180	0	13	414	2,30	6,18	2,49
	Tchangalari	180	0	13	298	1,66	5,06	2,25

For each species, there is therefore a minimum, a maximum and an optimum temperature for the vital processes. These thermal characteristics are therefore variable according to species, their stages of development and other ecological factors (Menèndez, 2007).Shanower *et al*. (1993a) has studied the development of *S. calamistis* under controlled conditions. Under artificialdiet, it took 709 degree-days (DJ) to achieve complete development; 122 DJs for eggs below a threshold of 9.7°C; 383 DJ for caterpillars above a threshold of 12.2°C and 204 DJ for nymphs above a threshold of 10.2 ° C. Orang *et al*. (2014) studying the effect of temperature on the development of larval stages of *Sesamia cretica* (Lederer) noted optimal temperatures of 35.50; 31.80; 33.35 and 32.22°C respectively for incubation, larval development, metamorphosis and adult phase. Non-lethal high temperatures were 38.93; 39.19°C; 37.41°C and 36.55°C and the minimum temperatures were 10.82°C; 11.81°C; 9.35°C and 10.67°C respectively for incubation, larval development, metamorphosis and adult stage. Average temperatures recorded in the Diamare Division (Figures II) are within the orders of magnitude of *Sesamia cretica* (Lederer) development temperatures; which would justify their height abundance in all sampled localities; moreover, *S.cretica* (Lederer) can develop throughout the year and the last generation infesting the transplanted sorghum would be the one that diapause at the larval stage either in the stems used as fodder or for the construction of the thatched roofs, or in the other alternative hosts used as refuges during the dry season. The agricultural landscape, natural habitats (as elements of the agro-ecosystem) and cultural practices thus play a very important role in the development of these pests.

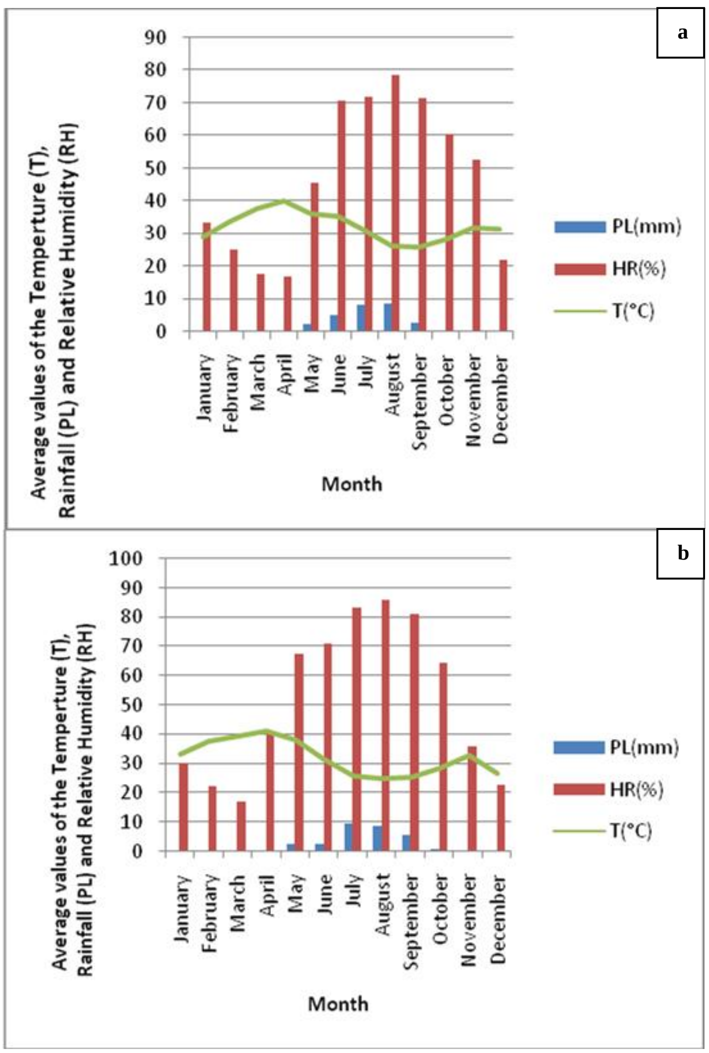

Figure II: Variations in Mean Temperature, Rainfall and Relative Humidity in the Far-North Region a: in 2011 and b: in 2012 (based on IRAD records, Regional Station of Maroua).

The development of the populations of caterpillars on the transplanted sorghum is thus dependent on the combined effects of climatic factors, environment and the varietal resistance which itself depends on the varietal genetic predispositions; to these factors are added the mechanisms for circumventing the defense of plants developed by pests in this coevolutionary and conflictual relationship. This leads to populations of caterpillars that may vary from one locality to another, in terms of abundance and biodiversity, depending on the levels of varietal defense of the transplanted sorghum plant and environmental conditions.

Conclusion

The work carried out in farmer fields and experimental station on transplanted sorghum under natural infestation by stem borers in the Far-North Region of Cameroon, has made possible to highlight abundance and biodiversity of drillers populations that vary according to the localities and local varieties of transplanted sorghum. It highlights the role of cultural techniques and environmental conditions in the development of pests. It also notes the need for global management of stem borers at the regional scale and the varietal improvement of this off-season sorghum for his resistance to its main pest, *Sesamia cretica*.

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