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Effects of maize-cowpea association on *Sesamia calamistis* Hampson population dynamics in the same plot

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Abstract

In Africa, particularly in Senegal, the production of *Zea mays* L. has suffered considerable damage caused by *Sesamia calamistis* Hampson. To solve this problem, we conducted a study whose objective is to ensure food and nutrition security in maize in Senegal, particularly in the communes of Keur Mandongo and Keur Madiabel. Thus, the implementation of a good methodology is essential to overcome this problem. It consisted of sowing a plot of 2500 m^2 of pure maize in rows, to introduce cowpea on these same lines (50 centimeters distance between the pockets) after emergence. And a pure corn indicator in lines was installed in the same area on the same day as the first plot. Maize stalks per plot are collected during two crop years on the dates: 30JAS, 45JAS, and 60JAS, to monitor the population dynamics of *S. calamistis* Hampson. The stems obtained (thirty per plot in total) were dissected to determine the attack rate. This made it possible to monitor the population dynamics of *S. calamistis* Hampson. The results showed that the population dynamics of the insect were negligible, hence the effectiveness of the cultural association between *Zea mays* L. and *Vigna unguiculata* L. Walp. At the end of this study, it was recommended results valuation by producers themselves and at around the world to safeguard food and nutrition security in maize.

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Introduction

Maize (*Zea mays* L.) is one of the most developed crops in the world and the first cereal produced ahead of wheat (*Triticum aestivum* L.) (FAOSTAT, 2016). In addition, this crop occupies more than 33 million hectares each year (FAOSTAT, 2015). In 2002, 73 countries, including 53 developing countries and 20 industrialized countries, each harvested more than 100,000 hectares of maize (FAOSTATS, 2002). However, in Senegal, in addition to the rainfall deficit limiting its production, stem borers such as *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae), *Eldana saccharina* Walker (Lepidoptera: Pyralidae), *Busseola fusca* Fuller (Lepidoptera: Noctuidae) are a real threat to this speculation. The damage of *S. calamistis* Hampson was most remarkable on the ground. This motivated our study on the contribution of corn stalk borer management. Thus, the objective of this study was to ensure food and nutrition security in maize in Senegal, particularly in the experimental area. This security can go even beyond our country. Maize is considered the best crop to meet the challenge of food security in Africa (Byerlee and Eicher, 1997). The management of *S. calamistis* Hampson was implemented by a biological control method. The latter consisted of sowing cowpeas on the maize lines after emergence. This association between *Vigna unguiculata* L. Walp and *Zea mays* L. is indispensable. Indeed, it is antiparasitic and would make it possible to follow the population dynamics of the targeted borer. This monitoring is, therefore, necessary to determine the attack rates of corn attributable to this stalk borer and better prepare producers for this phytosanitary problem. Perfect collaboration with the producers also makes it possible to carry out this important experiment properly. In addition, the general objective of this study would be to ensure food and nutritional security in maize in Senegal and in the world by actively participating in the reduction of climate change.

Materials and methods

The study was conducted in the municipalities of Keur mandongo (Cme of Kmo) and Keur madiabel (Cme of Kme). The Kmo Cme covers an area of 68 km².

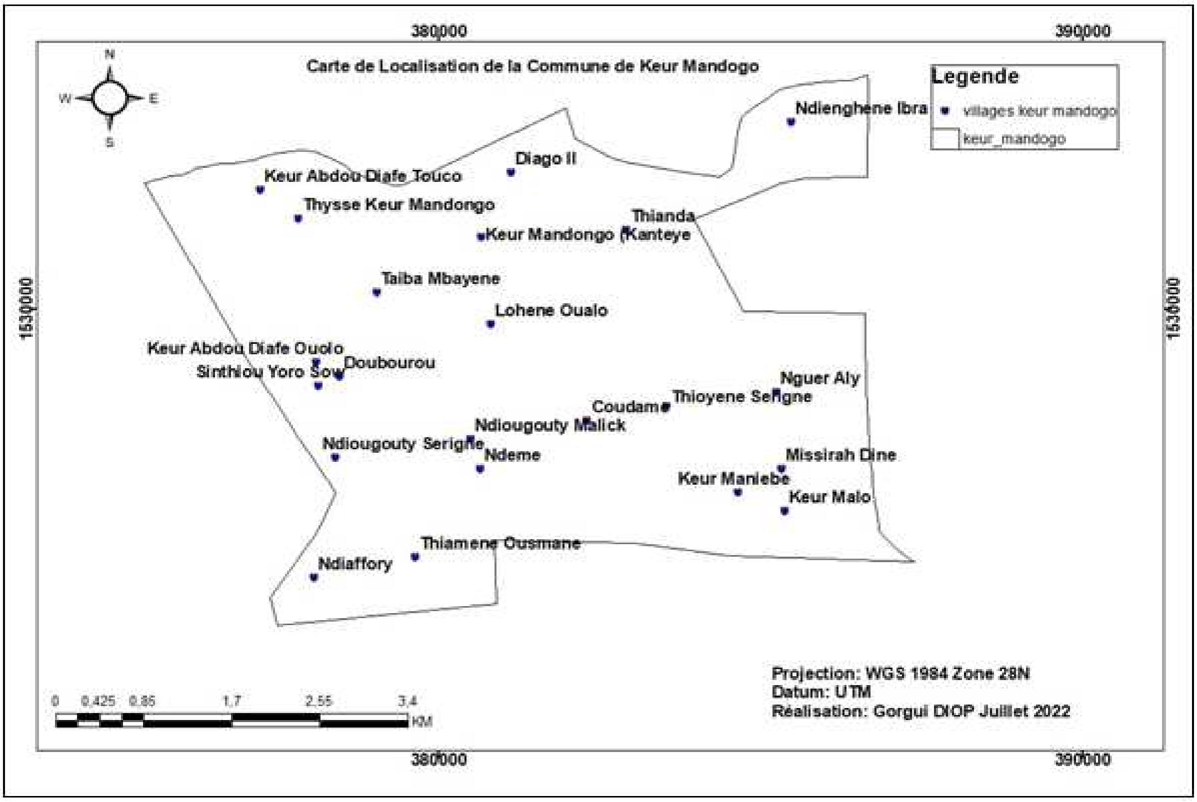

Fig. 1. Geographical position of the municipality of Keur Mandongo.

It is bordered to the north by the communes of Ndiédieng and Keur Socé, to the east by Cme of Kme, to the south by the commune of Wack Ngouna, and to the west by the commune of Ndramé Escale (see Fig 1.); while Kme is bordered to the south by the formerly rural community of Wack Ngouna, to the north and west by the formerly rural community of Kmo and the east by the formerly rural community of Gainte Kaye (see Fig 2.).

The latter is 33 km from Kaolack, 220 km from Dakar, and 27 km from the border with the Gambia. Both Cme is also part of the department of Nioro and the district of Wack Ngouna. In addition, the methodology used during this field experiment consisted of sowing pure maize in rows in a plot of 2500 m². A week after the maize is sown (after the maize has emerged), cowpeas are sown on the first line, with spacings of fifty centimeters. We skip the second line of maize by sowing cowpeas on the third line. This process of sowing cowpea on maize lines continues until the end. The presence of these two crops (maize and cowpea) in the same plot constitutes the cultural association. Next to this associated plot, a plot of pure corn in the same area was installed, constituting the witness. In addition, maize stalks were sampled at both plots. To do this, the operator must be placed on one end of the diagonal of the parcel. He takes a rod from the first line on the right and skips six lines then takes another rod on the left on the seventh line and continues this process in the direction of the diagonals until ten rods are obtained for the first date of sampling (30JAS). For the second sampling date (45JAS), he repeats the same process by changing the diagonal. Finally, for the third date (60JAS), he takes five stems in the direction of each diagonal and per plot. He must also skip twelve lines after each sample. In total, thirty branches were collected during these three dates both from the associated plot and at the control level. The stems taken were immediately dissected. This methodology adopted during this study will make it possible to monitor the evolution of the population dynamics of *S. calamistis* Hampson. In addition, the implementation of this methodology would require the appropriate choice of equipment. Thus, the latter will be essentially composed of: a knife, cutter, bag, notebook, gloves, and glasses. Excel software was also used for the construction of the figures. To better analyze the data obtained and to facilitate the proper preparation of the tables, it was considered necessary to use abbreviations. These are presented as follows : Kack : producer ; Pcl : plot ; DPvmt : date of stem collection ; Ntp : number of stems removed ; Nta : number of branches attacked ; % ta percentage of stems attacked ; M-N : maize-cowpea ; MP : pure maize ; Cge : campaign ; Vv : stem sampling ; 30JAS : thirty days after sowing ; 45JAS : forty-five days after sowing, 60JAS : sixty days after sowing.

Results

The implementation of this methodology made it possible to monitor the evolution of the population dynamics of *S. calamistis* Hampson during the two campaigns. This led to the results presented in Tables 1 and 2.

Table 1. Maize stalk sampling and attack percentages in 2019-2020 (Results).

Cge	Kack	DPvt	Ntp		Nta		%ta	
			Pcl_1 (M-N)	Pcl_3 (MP)	Pcl_1 (M-N)	Pcl_3 (MP)	Pcl_1 (M-N)	Pcl_3 (MP)
2019-2020	$Kack_1$	30JAS, 45JAS, 60JAS	30	30	0	0	0	0
	$Kack_2$	30JAS, 45JAS, 60JAS	30	30	0	0	0	0
	$Kack_3$	30JAS, 45JAS, 60JAS	30	30	0	0	0	0
	$Kack_4$	30JAS, 45JAS, 60JAS	30	30	0	0	0	0
	$Kack_5$	30JAS, 45JAS, 60JAS	30	30	0	0	0	0
	$Kack_6$	30JAS, 45JAS, 60JAS	30	30	0	0	0	0

Table 1 recorded the results of the 2019-2020 season that showed the different producers, the dates of stem collection, the number of stems collected from the associated and control plots, the number of stems attacked by *S. calamistis* Hampson, and the percentage of attack by *S. calamistis* Hampson. Table 2 explains the results of the second season for producers, stem sampling dates, number of stems taken from the associated and control plots, number of stems attacked by *S. calamistis* Hampson, and percentage of attacks by *S. calamistis* Hampson. In addition, it should be noted that the small difference between these two tables lies mainly in the number of producers, the dates of stem sampling, and the number of stems taken. Thus, in Table 1, six growers, three different stem collection dates, and a total of thirty stems were collected by Pcl and Kack. While at Table 2 level, we recorded two Kack, two DPvt for Kack1, one DPvt for Kack2, and one Ntp per Pcl and per Kack lower than that in Table 1. The difference in the number of Kack could be explained by producers' access to agricultural inputs related to their high cost and insufficient plots of arable land. For the Ntp, the reason likely to be cited is the delay for the second CGE having recorded very late sowing of maize. As a result, maize was unable to complete its cycle.

Table 2. Rod collection and attack percentages in 2020-2021 (Results).

Cge	Kack	DPvmt	Pcl(72m²)	Ntp	Nta	%ta
2020-2021	$Kack_1$	30JAS, 45JAS	Pcl_1 (M-N)	3	0	0
		30JAS, 45JAS	Pcl_3 (MP)	3	0	0
		30JAS, 45JAS	Pcl_5 (MP)	6	0	0
		30JAS, 45JAS	Pcl_6 (M-N)	4	0	0
		30JAS, 45JAS	Pcl_7 (MP)	5	0	0
		30JAS, 45JAS	Pcl_8 (M-N)	8	0	0
	$Kack_2$	30JAS	Pcl_1 (M-N)	5	0	0
		30JAS	Pcl_3 (MP)	4	0	0
		30JAS	Pcl_5 (MP)	3	0	0
		30JAS	Pcl_6 (M-N)	6	0	0
		30JAS	Pcl_7 (MP)	8	0	0
		30JAS	Pcl_8 (M-N)	7	0	0

Discussion

The results of both campaigns revealed the effectiveness of combining cowpea with maize as an organic method of protecting maize against the stalk borer *Sesamia calamistis* Hampson. There are also other species of borers impacted by cowpea: *Chilo partellus* (Swinhoe), *and C. orichalcociliellus* (Skovgad and Pats, 1997). Because cowpea acted as a physical barrier to maize vis-à-vis this borer. This result could be confirmed by Kareiva (1983) and Tonhasca and Byrne (1994), cited by Skovgad and Pats (1997) who said that cowpea would act by hindering the movements of rod borers (Non-trophic effect–physical barrier). Also, cited by Skovgad and Pats (1997), cowpeas act by hindering and increasing the influence of their natural enemies (Sheehan, 1986, Letourneau, 1987, Russell, 1989). In addition, cowpea could attract *Sesamia calamistis* Hampson and provide better protection for maize.

This result is close to the work of Kfir and *al.*, 2002 who considered cowpea as a trap plant preferred by the oviposition of the eggs of *C. partellus*, a borer of stems such as *Sesamia calamistis* Hampson. In addition, egg larvae have difficulty reaching maize cultivation (Ampong-Nyarko and *al.* 1994). But this phenomenon is all the more significant as the distance separating cowpea from crops is great.

Its role in this complex could be likened to the pull (attraction of pests that no longer focus only on the main crop). Better still, Hassanali and al., 2007 confirmed the relatively interesting role that cowpeas can play in the "push-pull" complex.

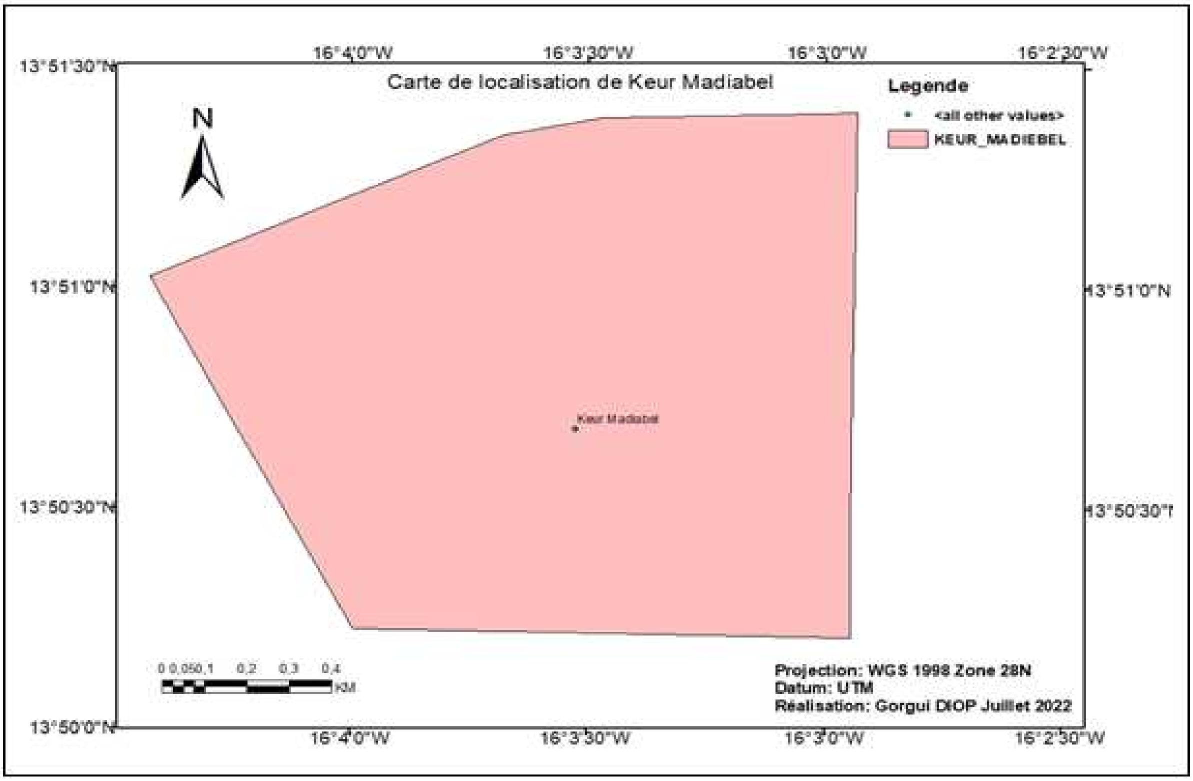

Fig. 2. Geographical position of the commune of Keur Madiabel (Materials and methods).

In addition, cowpeas could be assimilated as shelters from natural predators of *Chilo partellus Swinhoe*, *Sesamia calamistis* Hampson, etc. which would provide better protection of maize against these borers. This result could be confirmed by the work of Khan (2002) who showed the influence of predators such as *Denticasmias busseolae* and *Neotrichoporoides sp.* on the hatching of the eggs of these borers (95-98% mortality), due to their development.

Conclusion

Overall, the results of this study revealed a perfect mastery of the population dynamics of *S. calamistis* Hampson in the study area. This proved the effectiveness of the biological control method used. In addition, we recommend it to all Senegalese or foreign maize producers to ensure food and nutrition security in their localities.

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