DIVERSITY AND SEASONAL DYNAMICS OF FAUNA ASSOCIATED WITH *BRASSICA OLERACEA VAR. CAPITATA (L., 1753)* IN NKOLBISSON (CENTRAL REGION)

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ABSTRACT

To ensure food security in Cameroon, a study was planned to investigate the suitability of growing cabbage in the central region of Yaoundé. To this end, a field experiment was conducted over two climatic periods (dry and wet) to determine the entomofauna of this crop, with the aim of later considering agroecological methods of pest control. A weekly inventory was carried out, and the adult and juvenile stages of insects found in the field were recorded. This revealed that 55 species belonging to eight orders had colonised the cabbage. These included Hemiptera, Lepidoptera, Coleoptera, Diptera, Orthoptera, Hymenoptera, Dictyoptera and Arachnida. There was a significant difference in the abundance of these insects between the wet and dry seasons (P=0.000). Their activity on the plant enabled eight trophic groups to be distinguished, the most prevalent of which were piercing-sucking insects (80%) and leaf-eating insects (15%), which proved particularly devastating during the dry season. The recurrent and aggressive species Plutella xylostella, Spodoptera exegua and Spodoptera littoralis, which belong to the order Lepidoptera, had respective incidences of 80%, 76% and 62%. These three species alone were responsible for the destruction of almost the entire field. The results obtained during this study could inform the development of strategies to protect this plant.

Keywords: Inventory, Cabbage, Insect, protection, food safety.

1. INTRODUCTION

Cabbage cultivation represents a significant food resource, with a global production exceeding 70 million tonnes (Hasheela *et al*., 2010). This production is becoming increasingly important in the contemporary era, at a time when the global urban population has exceeded the rural population for the first time (Labou, 2016). Nevertheless, the provision of adequate and nutritious sustenance to urban populations is anticipated to be a pivotal challenge in the forthcoming decades (Argenti, 2010). On a global scale, the cultivation of cabbage is of paramount importance in the context of food and nutrition security programmes (Jhumar et al. 2024). As with all cruciferous vegetables, cabbage is rich in fibre, vitamins, minerals and trace elements (Jhumar et al. 2021), which helps to combat malnutrition (Kam, 2005). According to data from Hasheela *et al*. (2010), African production accounts for a mere 5.8% of global production. Cabbage (Brassica oleracea var. capitata) is one of the most widely grown and consumed vegetables. This is due to its relatively short growth cycle (60-90 days after transplanting) and the possibility of being cultivated throughout the year (Labou, 2016). Since 2013, Niger has been the leading producer of cabbage in sub-Saharan Africa, with more than 60,000 tonnes cultivated on over 3,500 hectares of land (Madou *et al.*, 2025). Cabbage cultivation represents a significant economic activity, providing a means of income and employment for urban and peri-urban populations. In Cameroon, however, national cabbage production is primarily concentrated in the western and north-western regions, a phenomenon attributable to climatic conditions that are conducive to its cultivation (Djomaha and Ghogomu, 2016). In 2007, the production was recorded at 37,000 tonnes across an area of 3,000 hectares, yielding an average of 12.3 tonnes per hectare (Djomaha and Ghogomu, 2016). Cabbage therefore occupies a very important place in the customs of the populations of the western region, where it is considered a cash crop because it is mainly cultivated by men (Djomaha and Ghogomu, 2016). Regrettably, in the central region, particularly in Yaoundé, cabbage cultivation is virtually non-existent. However, as the global population continues to grow, so too do its consumption needs. In order to address this elevated demand, plans are underway to extend the cultivation of this vegetable to other regions of the country, including the south, east and centre. In order to achieve this objective, it is essential to observe its adaptability to environmental conditions, pests and diseases in these regions. As with all crops and cultivated plants, cabbage is subject to significant production constraints that must be addressed (Charleston et al., 2005; Voula et al., 2020). Favourable climatic conditions have been identified as a primary factor contributing to the damage caused by insects (Imam et al., 2010; Walangululu and Mushagalusa, 2000; and Voula et al., 2023b). In light of the aforementioned considerations, a study was undertaken in the marshy lowlands of Nkolbisson with the overarching objective of ascertaining the factors impeding cabbage production in Yaoundé. Among the abovementioned factors, pests and microscopic fungi responsible for cabbage diseases have the capacity to significantly reduce yields. The study will therefore comprise two distinct components: the first being the cataloguing of the plant's insect pests, and the second being the assessment of their abundance and seasonality.

2. MATERIALS AND METHODS

Study site

The present study was conducted in the market gardening basin of the Nkolbisson marshlands (3° 52' 19'' N; 11° 27' 18'' E). The vegetation is dominated by Pennisetum purpureum (Pers., 1805), otherwise known as sissogho. The topography of Nkolbisson is predominantly undulating. The topography of the region is characterised by the presence of small plateaus and basins, in addition to a belt of hills that constitutes part of the seven hills of the city of Yaoundé. In addition, minor valleys have been identified. The hydrology of the region is characterised by the presence of a river known as Mefou, which is accompanied by a marsh. The latter is employed for market gardening during the dry season and, on occasion, during the rainy season. The region's climate is typified by a humid forest climate, with precipitation levels ranging from 1,500 mm to 2,500 mm. The region experiences four distinct seasons, characterised by varying lengths: a short dry season (June to mid-August), a protracted rainy season (mid-August to mid-March), a prolonged dry season (mid-November to mid-March), and a brief rainy season (mid-March to mid-June) (Voula et al., 2023).

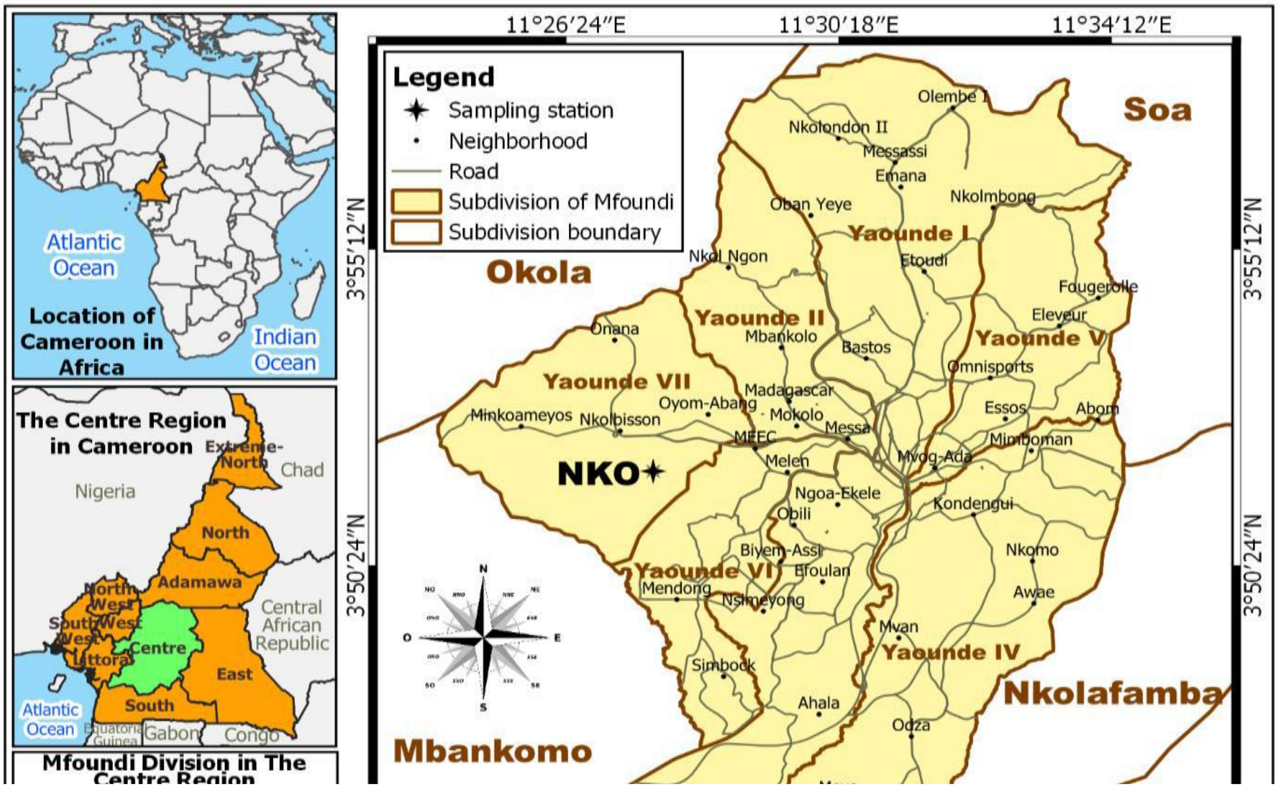

Figure 1: Map of the study site: graphic representation of Nkolbisson (Voula et al., 2023)

Methodology

The Madiba variety of cabbage is the best known and most widely consumed by farmers. It is a 4-month tropical hybrid with a compact, semi-spherical head.

Nursery

The establishment of the nursery involved the procurement of seeds from reputable market outlets. The objective was to utilise the same seeds as those employed by the producers. An area that was deemed suitable was selected in close proximity to the water source on the designated plot. An area of approximately 2m² of nursery was utilised for approximately 4 to 5g of seed. The soil was ploughed, loosened and enriched with 5g of decomposed chicken manure, which was utilised as the biofertiliser. The soil was subsequently treated with a nematicide. The seeds of the cabbage were then placed between the pre-made rows, which were 10 centimetres apart. The seeds were then covered with a thin layer of soil. Watering was conducted on a regular basis, with two 10-litre watering cans being utilised in the morning and evening to ensure adequate hydration. The beds were covered with dead oil palm leaves in order to reduce evapotranspiration. Six weeks after sowing, seedlings measuring 10 to 15 cm with 6 to 8 true leaves were transplanted to the experimental plot.

Experimental setup

The experimental plot encompassed an area of 1,200 m², which was subdivided into six blocks. Each block was subdivided into three units, or elementary plots, measuring 5 m × 4 m, or 20 m².

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Each elementary plot contained five beds, each measuring six metres in length. The experiment comprised a total of 18 elementary plots. The distance between the beds was 0.8 m, and the distance between the plants was 1 m. This configuration resulted in 30 plants per experimental unit. The distance between each unit was 2 metres, resulting in a total of 540 cabbage plants, equivalent to 90 plants per block. In the eighth week, the young plants were transplanted to the experimental plot. In accordance with the prescribed protocol, the plot was subjected to a series of agronomic treatments, including cleaning, ploughing, staking, and fertilising with chicken manure that had undergone decomposition.

Inventory of fauna in the experimental plot

Forty-five days after transplantation, observations were initiated. These were conducted during the early hours of the morning, between 6am and 10am, on a weekly basis. A meticulous examination of each cabbage plant was conducted as part of the specimen inventory. During this examination, the leaves on both sides were meticulously scrutinised. The various arthropods observed were captured, and their activity on the plant was noted. These subjects were preserved in tubes containing 70% alcohol. Each tube was meticulously labelled with the pertinent date, geographical location, and time of collection. Immature forms (butterfly larvae or caterpillars) were maintained in rearing boxes and transported to the laboratory. These specimens were meticulously maintained until they reached adulthood. All samples collected in situ were subsequently transported to the Central Entomology Laboratory of the Agricultural Research Institute for Development (IRAD) in Nkolbisson for subsequent identification. The categorisation of trophic groups was determined by the activity of the individuals and the manner of their feeding on the plant.

Assessment of the intensity of insect attacks on cabbage

The assessment of pest damage and the abundance of major insects was carried out using a damage intensity index (I). The calculation of these values was performed utilising a formula that incorporated the percentage of plants attacked at varying levels of attack. The following scale was utilised to define the four levels of attack: Level 1: low intensity damage ($0\% < I \leq 10\%$), Level 2: medium intensity damage ($10\% < I \leq 30\%$), Level 3: high intensity damage ($30\% < I \leq 50\%$), Level 4: very high intensity damage ($50\% < I \leq 100\%$). The index (I) was consequently calculated using the following formula:

The following equation is to be used:

$I = Pm \times 100/Po + Pm$

P_O is a numerical value representing the quantity of healthy plants.

The Pm method is a quantitative approach that estimates the number of plants that have been subjected to attack. This method enables the categorisation of pests as minor, significant or major according to the intensity of the damage they cause.

Specimen identification

The identification of the samples was conducted at the Central Entomology Laboratory in Nkolbisson, employing dichotomous keys developed by various authors. These included Delvare and Aberlenc (1989) for the classification of insect families, Villier (1952) and Couilloud (1989) for Hemiptera, Blackman and Eastop (2000) for Aphididae, and finally Mestre (1988) for Orthoptera.

Data analysis

The relative abundances of the different species collected were calculated. The variation in abundance of the main species identified was tested using the Generalised Linear Model (GLM). The procedure under discussion incorporates a linear regression analysis, followed by an Analysis of Variance (ANOVA). The Poisson correction was thus applied to the count data. The relationship between the main species identified and their natural enemies was identified through the implementation of Spearman's correlation test. Pairwise comparisons were performed using Tukey's HSD test, corrected by Bonferroni's sequential procedure. The analyses were performed using R software (Version 3.0.2, 2013). The assessment of all other results was conducted at the 5% threshold.

3. RESULTS

Fauna inventory

The inventory of fauna identified 9,954 individuals in the field, classified into eight orders, 26 families and 55 species. It appears that these species are distributed unevenly across the two periods. The dry period registered 8,407 individuals, while the wet period documented 1,547. A comparison of absolute abundances between the dry season and the wet season shows a highly significant difference (F=2.840; P=0.0000***).

Variation in insect abundances at the order level and according to climatic periods

Of the eight orders collected on cabbage in the experimental plot, Hemiptera were found to be numerically more abundant, with a relative abundance of 74.10%. The observed abundance exhibited a marked variation, ranging from 45.76% during wet periods to 79.28% during dry periods. A comparison of abundances between wet and dry periods shows a highly significant difference (F=3.273; P=0.000). The Lepidoptera order was the next most abundant, with a total relative abundance of 14.42%. In contrast to the findings observed in Hemiptera, the relative abundance of Lepidoptera was found to be significantly higher during wet periods (29.73%) in comparison to dry periods (11.62%) (see Table I for details). A comparison was made between the wet and dry periods, and it was found that there were highly significant differences (F = 0.662; P = 0.000). Finally, Coleoptera, Diptera, Orthoptera, Hymenoptera, Dictyoptera and Arachnida were observed. A comparison was made between wet and dry periods, with significant differences being revealed for all orders (P = 0.000; see Table I). The orders in question presented a number of species that varied greatly depending on the period. In this regard, while the order Orthoptera was of minimal significance, it exhibited the highest species richness (19), which exhibited substantial variation between the two periods. Specifically, three species were observed in wet periods, while a pronounced proliferation of 16 species was documented in dry periods. This was succeeded by the order Coleoptera, which encompassed a total of 13 species. During the wet season, three species were recorded, whereas during the dry season, 10 species were documented. The orders Hemiptera and Diptera each contained seven species. During the wet season, the Diptera exhibited a single species, while the Hemiptera demonstrated three distinct species. During the dry season, the diptera exhibited six species, while the hemiptera displayed four. The number of species observed in Lepidoptera remained consistent across both seasons, with three species recorded during the wet season and three species documented during the dry season. In contrast, arachnids and dictyoptera were present in both seasons, irrespective of precipitation. Arachnids were exclusively observed during the dry season, with only one species, while dictyoptera were predominantly present during the wet season, with two species.

Table I: Distribution of the different orders of arthropods and the number of species according to the seasons

Ordres	Wet season			Dry Seasons			Total			F test (GLMproc)
	Number Species	AA	AR	Number Species	AA	AR	Number Species	AA	AR	
Lepidoptera	3	460	29,73	3	983	11,62	**6**	1443	14,42	F=0,662 ; P=0,0000***
Arachnida	0	0	0,00	1	40	0,47	**1**	40	0,39	F=0,018 ; P=0,0000***
Coleoptera	3	210	13,57	10	162	1,91	**13**	372	3,71	F=0,167 ; P=0,0000***
Dictyoptera	2	70	4,52	0	0	0,00	**2**	70	0,69	F=0,031 ; P=0,0000***
Diptera	1	32	2,06	6	310	3,66	**7**	342	3,41	F=0,151 ; P=0,0004***
Hemiptera	3	708	45,76	4	6706	79,28	**7**	7414	74,10	F=3,273 ; P=0,000**
Hymenoptera	1	30	1,93	3	105	1,24	**4**	135	1,34	F=0,059 ; P=0,00007***
Orthoptera	3	37	2,39	16	152	1,79	**19**	189	1,88	F=0,082 ; P=0,00009***
Total général	16	1547	100	43	8458	100	**59**	10005	100	

Legend: (AA=absolute abundance; RA=relative abundance; ***=highly significant; **=very significant)

Most abundant specific variations according to the seasons

The cabbage was heavily colonised by numerous insects. A total of 55 species were observed, the damage caused by which remains to be assessed. Among these species, the most significant and recurrent species observed only during wet periods were *Bemesia tabacci*, with an occurrence of 450 (29.09), followed by *Acyrthosiphon pisum*, with an occurrence of 253 (16.35), and finally *Parexochomus nigromaculatus*, with an occurrence of 80 (5.17). Those observed only during the dry season were *Brevicoryne brassicae*, with an occurrence of 6,506 (77.39), followed by *Picromerus bidens*, with an occurrence of 180 (2.14), and finally *Stenichnus collaris*, with an occurrence of 80 (0.95) (Table II). During the dry season, however, the most abundant and recurrent species were *Brevicoryne brassicae* 6506 (77.39), followed by *Picromerus bidens* 180 (2.14) and *Stenichnus collaris* 80 (0.95) (Table II). A comparison between the species found during the wet season and those found during the dry season reveals significant differences (p=0.005). In addition to these insects, some were found in both the wet and dry seasons. These included *Plutella xylostella*, which was more prevalent in the dry season with an occurrence of 552 (6.57) than in the wet season with an occurrence of 218 (14.09). It is followed by

Spodoptera exegua, which had an occurrence of 330 (3.93) during the dry season and an occurrence of 130 (8.40) during the wet season. The comparison between these two periods reveals significant differences (N= 3.12; P=0.002). Finally, the species *Spodoptera Littoralis* had an occurrence of 101(1.20) in the dry season and an occurrence of 60 (3.88) in the wet season. The comparison between the two periods also shows significant differences (N= 3.45; P=0.001). In view of the above, these insects (*Spodoptera exegua*, *Spodoptera Littoralis Plutella xylostella* and many others) were more abundant in dry periods. The insects that appeared in both dry and wet periods had a strong negative impact on cabbage. This impact was more pronounced in dry periods, with incidences greater than or equal to 60%.

The intensity of the attacks varied between 7% and 80%. Three species stood out in particular: Plutella xylostella, Spodoptera exegua and Spodoptera littoralis, with incidences of 80%, 76% and 62% respectively. These three species were very aggressive and alone contributed to the almost total destruction of the field. The least aggressive, on the other hand, were *Stenichnus collaris*, *Parexochomus nigromaculatus* and *Acyrthosiphon pisum*, with respective incidences of 7%, 10% and 15%. The impact of cabbage pests requires the urgent implementation of control methods.

Table II. Variation in the most abundant and recurrent species according to the seasons

Espèces330(3,93)	**Wet season**		**Dry season**		**Total**		**Incidence (%)**
	AA	Occurrence	AA	Occurrence	AA	Occurrence	
Acyrthosiphon pisum	253	253(16,35)	0	0(0,00)	253	253(2,83)	15
Bemesia tabacci	450	450(29,09)	0	0(0,00)	450	450(5,03)	25
Parexochomus nigromaculatus	80	80(5,17)	0	0(0,00)	80	80(0,89)	10
Plutella xylostella	218	218(14,09)	552	552(6,57)	770	770(8,61)	80
Spodoptera exegua	130	130(8,40)	330	330(3,93)	460	460(5,15)	76
Spodoptera Littoralis	60	60(3,88)	101	101(1,20)	161	161(1,80)	62
Brevicoryne brassicae	0	0(0,00)	6506	6506(77,39)	6506	6506(72,77)	20
Picromerus bidens	0	0(0,00)	180	180(2,14)	180	180(2,01)	34
Stenichnus collaris	0	0(0,00)	80	80(0,95)	80	80(0,89)	7
Total	1191	1191(100)	7749	7749(100)	8940	8940(100,00)	

Key: (AA=absolute abundance; ***=highly significant; **=very significant)

Other less abundant and less recurrent species also varied according to climatic periods (Table III). Among the latter, a large population of orthoptera was recorded, represented by species such as *Locusta migratoria* 5(0.06), *Pyrgomorpha conica* 25(0.3) and Zonocerus variegatus 35(2.36) and many others. These orthoptera were mainly present during the dry season, with the exception of Zonocerus variegatus, which was found in both wet and dry periods. No significant difference was noted between the two climatic periods. These species of orthoptera associated with lepidoptera significantly increase the parasitic pressure on cabbage by massively destroying the leaves (P=0.000). Other groups such as ants and hemiptera (*Camponotus pennsylvanicus* 60(0.71); *Bemesia tabacci* 450(29.09)) are strongly represented and associated, suggesting that they live in communities. There are also numerous beneficial insects, such as Ichneumon suspiciosus, which is a parasitoid of butterfly larvae. It was very common during the dry season, while *Crioceris duodecimpunctata* is a predator 40(0.48) and was also very common during the dry season.

Table III. Specific abundance associated with cabbage according to climatic periods

Espèces	Wet season		Dry season		General Total		F test
	AA	RA	AA	RA	AA	RA	
Acrida cinerea	0	0	1	0,01	1	0,01	F= 0,342; P=0,012 NS
Acrida bicolor	5	0,32	0	0,00	5	0,05	F=2,445 ; P=0,0546 NS
Acrida exalta	1	0,06	0	0,00	1	0,01	F=1,922 ; P=0,854 NS
Acrida ungarica	0	0,00	12	0,14	12	0,12	F=5,212 ; P=0,0000***
Acyrthosiphon pisum	253	16,35	0	0,00	253	2,54	F=1,156 P=0,415 NS
Aesiotyche favosa	0	0,00	5	0,06	5	0,05	F=1,180 ; P=0,341 NS
Angelastica alini	0	0,00	5	0,06	5	0,05	F=2,130 ; P=0,523 NS
Bemesia tabacci	450	29,09	0	0,00	450	4,52	F=3,572 ; P=0,0455NS
Blackburneus sterorosis	0	0,00	15	0,18	15	0,15	F=1,180 ; P=0,423 NS
Brevicoryne brassicae	0	0,00	6506	77,39	6506	65,36	F=1,880 ; P=0,0000***
Bruchidius ater	0	0,00	40	0,48	40	0,40	F=1,000 P=0,0115*
Camponotus pennsylvanicus	0	0,00	60	0,71	60	0,60	F=21,240 ; P=0,0000***
Chrysochraon dispar	0	0,00	1	0,01	1	0,01	F=3,540 ; P=0,0145NS
Crioceris duodecimpunctata	0	0,00	40	0,48	40	0,40	F=3,540 ; P=0,0145NS
Delia platura	0	0,00	40	0,48	40	0,40	F=9,440 ; P=0,005**
Delia radicum	0	0,00	205	2,44	205	2,06	F=1,180 ; P=0,423 NS
Derocrepis rufipes	0	0,00	5	0,06	5	0,05	F=1,556 ; P=0,000***
Diaeretiella rapae	30	1,94	0	0,00	30	0,30	F= 42,480 P=0,000***

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Dissosteria carolina	0	0,00	82	0,98	82	0,82	F=181,720 ; P=0,000***
Ectobicus vinzi	30	1,94	0	0,00	30	0,30	F=1,160 ; P=0,0702NS
Eurysternacris brevipes	1	0,06	0	0,00	1	0,01	F=1,880 ; P=0,0000***
Hermecia illucens	0	0,00	15	0,18	15	0,15	F=3,540 ; P=0,0145NS
Hydrometra martini	0	0,00	15	0,18	15	0,15	F=1,732 ; P=0,614NS
Ichneumon suspiciosus	0	0,00	15	0,18	15	0,15	F=1,440 ; P=0,005**
Leptophysa sp.	0	0,00	1	0,01	1	0,01	F=3,540 ; P=0,0145NS
Lepyronia quadriangularis	0	0,00	5	0,06	5	0,05	F=1,662 ; P=1,0000
Lochmaea CF caprea	5	0,32	0	0,00	5	0,05	F= 0,662; P=0,012 NS
Locusta migratoria	0	0,00	5	0,06	5	0,03	F=1,180 ; P=0,341 NS
Longitarsus pratensis	0	0,00	1	0,01	1	0,01	=1,180 ; P=0,341 NS
Mantis religiosa	40	2,59	0	0,00	40	0,40	F=0,156 P=0,0115*
Meloe proscarabeus	0	0,00	5	0,06	5	0,05	F=1,180 ; P=0,341 NS
Microtes sp.	0	0,00	1	0,01	1	0,01	F=1,180 ; P=0,423 NS
Oedaleus turquoise	0	0,00	15	0,18	15	0,15	F=53,572 ; P=0,0455NS
Oliarius humulis	5	0,32	0	0,00	5	0,05	F=1,180 ; P=0,423 NS
Parexochomus nigromaculatus	80	5,17	0	0,00	80	0,80	F=8,880 ; P=0,0000***
Pegonia sp.	0	0,00	3	0,04	3	0,03	F=3,540 ; P=0,0145NS
phyllotreta crucifera	60	3,88	0	0,00	60	0,60	F=21,240 ; P=0,0000***
phyllotreta nemorum	70	4,52	0	0,00	70	0,70	F=46,556 ; P=0,000***
Picromerus bidens	0	0,00	180	2,14	180	1,81	F=3,540 ; P=0,0145NS
Plutella xylostella	218	14,09	552	6,57	770	7,74	F=3,640 ; P=0,005**

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Pyrgomorpha conica	0	0,00	25	0,30	25	0,25	F=6,556 ; P=0,000***
Sargus bipunctata	42	2,71	0	0,00	42	0,42	F=46,556 ; P=0,000***
Schistocera gregaria	0	0,00	2	0,02	2	0,02	F= 42,480 P=0,0658NS
Simulium argyreatum	0	0,00	5	0,06	5	0,05	F=181,720 ; P=0,000***
Simulium ornatum	32	2,07	0	0,00	32	0,32	F=14,160 ; P=0,0702NS
Solenopsis xyloni	0	0,00	30	0,36	30	0,30	F=18,880 ; P=0,0000***
Spodoptera exegua	130	8,40	330	3,93	460	4,62	F=3,540 ; P=0,0145NS
Spodoptera Littoralis	60	3,88	101	1,20	161	1,62	F=8,732 ; P=0,614NS
Stenichnus collaris	0	0,00	80	0,95	80	0,80	F=9,440 ; P=0,005**
Tenuitarsus sudanicus	0	0,00	1	0,01	1	0,01	F=3,540 ; P=0,0145NS
Tetrix subulata	0	0,00	2	0,02	2	0,02	F=0,462 ; P=0,784 NS
Tetrix tenuicornis	0	0,00	1	0,01	1	0,01	F=4,160 ; P=0,0602NS
Zonocerus variegatus	35	2,26	0	0,00	35	0,35	F=18,880 ; P=0,0000***
Total général	**1547**	100,00	**8407**	100,00	**9954**	100,00	

Legend: (AA=absolute abundance; RA=relative abundance; ***=highly significant; **=very significant)

These species (Figure 2) were also grouped into trophic groups based on their affinity with the plant. These include sucking pests, leaf feeders, honeydew feeders, parasitoids, licking pests and predators. Depending on the season, sucking pests were more abundant, accounting for 80% in dry periods and 45% in wet periods. They were followed by leaf feeders, which were more abundant in wet periods (29%) than in dry periods (15%). Similarly, predators were more abundant during wet periods (18%) and almost absent during dry periods (1%). Licking biters and parasitoids also followed the same trend. Honey feeders, on the other hand, were equally abundant during both wet and dry periods.

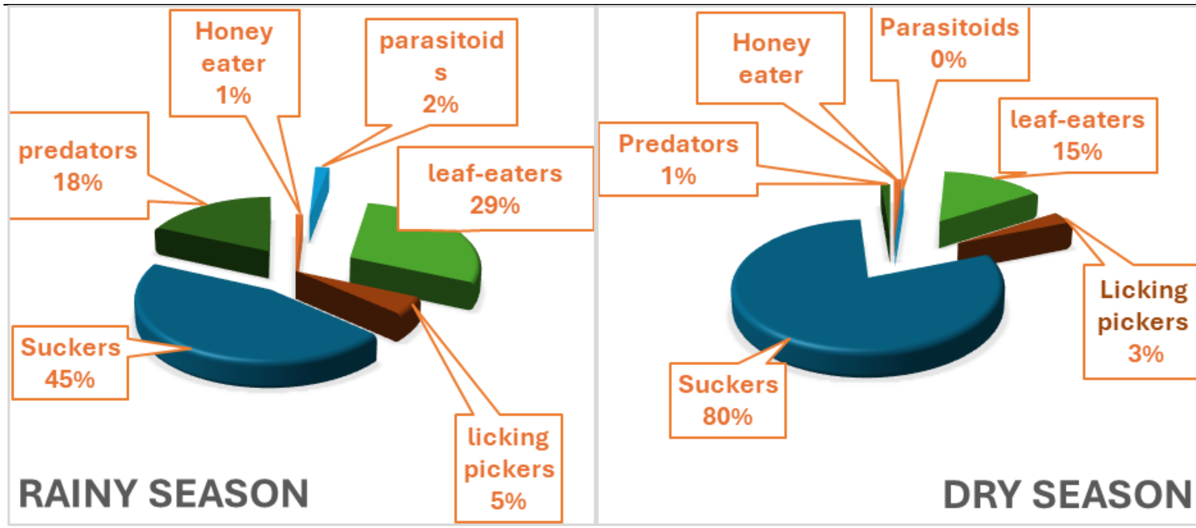

Figure 2: Representation of arthropod trophic groups associated with cabbage according to the seasons

4. DISCUSSION

Cabbage is a widely consumed vegetable in Cameroon, but it is grown almost exclusively in the western and north-western regions (Djomaha and Ghogomu, 2016). In these areas, it is considered a cash crop because it generates a lot of income and is cultivated by men (Djomaha and Ghogomu, 2016). The study on its adaptability in the Central region found that it is colonised by numerous insects, which can be a limiting factor for its production. The inventory identified 9,954 individuals divided into 8 orders, 26 families and 55 species in Yaoundé. This result seems more diverse than those obtained by many authors, such as Ouali n'Goran et al. (2021), who identified 15 species belonging to 5 orders, namely Lepidoptera, Diptera, Orthoptera, Hemiptera or Homoptera, and Coleoptera. Walangululu and Mushagalusa. (2000) recorded six species belonging to four orders on cabbage. The entomofauna of cabbage was very dense in Yaoundé-Nkolbissson, certainly due to the climate, which is very favourable to insect development, and the abundant and highly diverse vegetation (Khan et al., 2021). This vegetation acts as a reservoir for certain species passing through the environment (Voula et al., 2023). These insect pests were more numerous and virulent during the dry season. This corroborates the assertions of Walangululu and Mushagalusa. (2000) and Djomaha and Ghogomu. (2016), who reported in their work that peak populations of cabbage pests occurred during the dry season. This diversification can be explained in part by the fact that the work was carried out in a floodplain. On the other hand, heavy rains wash away insects, eggs and immature forms of insects on the plant (Djomaha and Ghogomu, 2016). This once again confirms the work of Djomaha and Ghogomu (2016) on cabbage in Dschang in 2008. They estimated that the period from September to December is more conducive to the development of moths, and this period is transitional between the end of the rains and the mid-dry season in the study area. The results obtained in this study once again corroborate those of Kouassi et al. (2019) conducted in Côte d'Ivoire. They identified 48 species, including 25 pests, with peaks in abundance of *Plutella xylostella* and *Lipaphis erisimi* during the vegetative phase and the ripening phase of the plant (Kouassi et al., 2019). This seasonal diversity may be linked to the different phenological stages of cabbage (Muller, 2018). This result can be used as a means of controlling cabbage pests, thus contributing to the agroecological management of this crop (Dzemo and Ntoukam, 2024). These results and observations obtained in Yaoundé-Nkolbisson can be integrated into agroecological practices that have been proven elsewhere, particularly in western and southwestern Cameroon. For example, a recent study in Dschang (2024) shows that agroforestry systems reduce the abundance of aphids (B. brassicae 0.71 ± 0.62) compared to a conventional system (25.31 ± 38.94) (Njouajio and Fengeh, 2024). In the lowlands of Nkolbisson, the adoption of intercropping could promote beneficial insects while limiting pests. Adjusting the cropping calendar (earlier or later planting dates) can also reduce infestations, as suggested in the 2018 study in Cameroon, where late plantings recorded almost no attacks by the cabbage moth *Plutella xylostella*. Furthermore, climate played an important role in the distribution of insects (Amougou et al., 2108). In this regard, the seasonal dynamics of fauna could be explained in part by variations in secondary compounds in cabbage, such as glucosinolates (Dzemo and Ntoukam, 2024). This phenomenon is well documented in wild B. oleracea. It is amplified when plants are under herbivorous pressure (heavy attack by butterfly larvae, orthoptera and many others) or significant climatic variations. Similarly, the increase in aphids during wet periods could be correlated with a relative decrease in the plant's chemical defences, favouring their proliferation (Kouassi et al., 2019).

Based on the activity of insect pests on cabbage, six trophic groups were identified, namely: piercing-sucking insects, leaf-eating insects, honeydew-feeding insects, parasitoids, piercing-licking insects and predators. These results are more diverse than those obtained by Voula et al. (2023), who identified four trophic groups in Nkolmelen. Piercing-sucking insects and leaf feeders were particularly harmful to the plant, causing significant damage. Leaf feeders consist of both orthoptera and lepidoptera (*Z. variegatus*, *P. xylostella*, *S. Littoralis*, etc.). Given the extent of the damage, control measures need to be put in place quickly (Voula et al., 2023) in Nkolbisson in the Central Cameroon region, which is new to cabbage cultivation. Of these 55 species of insect pests, eight were abundant: *Bemesia tabacci*, *Acyrthosiphon pisum*, *Parexochomus nigromaculatus*, *Plutella xylostella*, *Spodoptera exegua*, *Spodoptera Littoralis*, Brevicoryne brassicae, Picromerus bidens and Stenichnus collaris. Among these 8 species, three were recurrent and very aggressive, such as *Plutella xylostella*, *Spodoptera exegua*, and Spodoptera Littoralis, which caused significant damage with an incidence of between 60 and 80%. These results appear to be consistent with those of many authors (Walangululu and Mushagalusa, 2000; Djomaha and Ghogomu, 2016). Sengonga and Lui (2002) estimate that populations of cabbage pests, particularly *Plutella xylostella*, responsible for diamondback moth (DBM), and aphids are significant and can reach 40 to 70 individuals per 30 plants (Amougou et al., 2108). Most authors frequently cite *Plutella xylostella* (cabbage moth) and aphids (*Brevicoryne brassicae*, *Myzus persicae*) as pests in West Africa. For example, studies in Ghana and Senegal show their marked presence throughout the year, with a seasonal predominance of soft rot during hot and humid periods (Amougou et al., 2108). These insects are likely to cause significant yield losses, especially during rainy periods.

5. CONCLUSION

Ultimately, the results obtained allowed us to conclude, on the one hand, that cabbage can indeed be grown in the central region (Yaoundé) and, on the other hand, that cabbage is a plant that is highly susceptible to attack by numerous insects. The most destructive orders were Lepidoptera, Orthoptera and Diptera. In terms of trophic groups, piercing-sucking insects and leaf-eaters were very present and their damage was visible. However, in order to maintain an acceptable level of production, measures to control these pests must be put in place quickly by researchers. This study also fits perfectly with the recent trend towards sustainable and resilient agriculture in Central Africa, integrating seasonal understanding of pests, the key role of beneficial insects, and relevant agroecological levers (agroforestry, biopesticides, adapted calendars). This leads us perfectly to a robust and up-to-date contribution to the field of integrated pest management in tropical cabbage crops, enabling Cameroon to play its role as an agricultural leader in the Central African sub-region.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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