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(RESEARCH ARTICLE)

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Study of the insect pest African rice midge *Orseolia oryzivora* in the far north Cameroon

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Abstract

The objective of the study was to increase rice production by screening three (03) varieties of NERICA (New Rice for Africa) rice in the face of attacks from the African rice midge (*Orseolia oryzivora*) and to integrate efficient biological control in rainfed rice cultivation. During the rice crop cycle, each phenological stage of the plant is sampled every two weeks using the D-VAC vacuum cleaner and sweep net throughout the crop season given that this sampling frequency corresponded at a specific phenological stage. White hearts are sampled during the bolting stage of the plant. It consisted of randomly taking 20 plants of white hearts from each plot. The NERICA 3 variety is more sensitive than the other two varieties because it has more African rice midge population. African rice midge population abundance varies depending on the collection method (Sweep-Net and D-VAC). Collection using the D-VAC motor vacuum cleaner was found to be more efficient than that carried out by the Sweep-Net. Only 5 live African rice midge individuals were recovered out of the 38 observed. Mortality rates of 70% and 95% are observed respectively on NERICA 1 and NERICA 3. On NERICA 1, of the 14 dead pupae, 5 had *Aprostocetus* sp larvae while on NERICA 3, 8 *Aprostocetus sp* larvae were extracted of the 11 dead pupae. This high mortality rate is largely due to parasitism by *Aprostocetus* sp larvae and unfavorable environmental conditions during the migration of African rice midge larvae from the leaf blade to the base of the stem.

Keyword: Midge; Rice; NERICA; Maroua; Far North; Cameroon.

1. Introduction

Rice is the most important cereal crop in developing countries and constitutes a staple food for more than half of the world's population (Guigaz, 2002). It comes second after wheat in terms of cultivated area (156 million hectares) with world paddy production of 630 million tonnes in 2006 (FAO, 2006).

In Africa, paddy production also experienced an increase of around 12.63% or approximately 2.41 million tonnes in 2003 compared to 1997 production. West Africa comes in first place with 68.7%, followed by East Africa 12.3% and finally Central Africa 10.8% (Norman and Otoo, 2003).

In Cameroon, national production (58,000 tonnes) only covers 38% of food needs. This production is essentially propelled by the State, through the creation in the north of the country of the Société d'Expansion et de Modernization de la Riziculture de Yagoua (SEMRY), covering an area of approximately 11,518 hectares, which represents more than half of the irrigated land and alone provide at least 90% of national production.

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In the South, we also note the creation of the Society for the Development of Rice Culture in the Mbos Plain (SODERIM) and the "Upper Noun Valley Development Authority" (UNVDA) (Engola, 1991).

Despite its potential, Cameroon has imported around 400,000 tonnes each year since 2004, hence the need to increase national production in order to reduce imports (FAO, 2006). In the northern part, rice growing activity takes place in two types of ecosystem, namely: rainfed rice growing which is concentrated in the Bénoué valley and in the surrounding villages of Maroua (Meskine) and irrigated rice growing which is based in the Logone plain covering the area of Mayo Danay (Yagoua and Maga) and Logone and Chari (Kousseri).

Problem Faced with food insecurity which threatens all of humanity and particularly Africa, rice cultivation requires special attention because it feeds more than half of the world's population (Guigaz, 2002). This food insecurity is due to several factors: biotic, abiotic and managerial.

Cameroon is one of the countries most affected by the deficiency of this commodity which has become of strategic importance, it is therefore necessary to intensify rice cultivation in both ecosystems (rainfed and irrigated) in order to overcome this problem.

In view of this intensification, protecting crops against harmful insects is important. However, it is clear today that the African rice midge (AfRGM: *Orseolia oryzivora*) constitutes the most cited pest across Africa (Agen Sampong, 1982; Alam et al., 1985) requiring a study of the dynamics of its population in order to better control them and improve production.

Arhent and al. (1983) found that among the 41.1% of total rice losses, 27.5% were due to insects with almost 80% due to midge (*Orseolia oryzivora*) Descamps (1956).

Spectacular damage was recorded in the savannah zone of Nigeria (Ukwungu et al., 1989). In Mali, infections reached 80% on the BG 90-2 variety, widely cultivated by farmers (Hamadoun, 1996).

In Cameroon in 1954, Descamps (1956) reported that 75% of damage caused by midge was located in the Logone valley (Far North).

The African continent has experienced several attacks of this kind: In 1979, the irrigated rice farming project in Karfiguela (Burkina Faso) (Bonzi, 1979) was completely destroyed.

In 1988 and 1997 in the South-East of Nigeria (Ukwungwu et al 1989) and in 1991-92 in the Kapunga region in Tanzania (A. Frisby, personal communication, 1993). The cultivated areas affected by this disease are of the order of 800 to 50,000 ha and yield losses are estimated at nearly 80%. However, very little information is available on this disease (rice gall) which is already threatening in the northern part of Cameroon.

It is therefore necessary to evaluate the evolution of the population of this pest and their natural enemies in order to develop an efficient fight against its pests.

The general objective is to increase rice production by screening three (03) varieties of NERICA (New Rice for Africa) rice against attacks from the African rice midge (*Orseolia oryzivora*) and to integrate biological control efficient in rainfed rice cultivation in Guiring.

Specific objectives

- -Sample the African rice midge (AfRGM) population on all phenological stages of NERICA varieties;
- -Study the level of attack of African rice midge (AfRGM) on each variety of rice;
- -Inventory and breed natural antagonists of African rice midge (AfRGM);
    - Study the distribution over time following the phenological stages of the three varieties of NERICA.

2. Materials and methods

2.1. Location of the study area

2.1.1. Geographic characteristics

The Far North Cameroon region extends from the 8th to the 13th degree of north latitude. The study was carried out in the Diamaré plain (Maroua region), which runs from the 10th to the 11th parallel (Donfack, 1998).

The study was carried out on the IRAD experimental site in Maroua located approximately 5 km from the urban center, more precisely on the Guiring farm located on the Maroua-Bogo axis on the North-East side of the city.

2.1.2. Climatic characteristics of the study area

The Far North region of Cameroon is marked by a Soudono-Sahelian type climate (Donfack, 1998), characterized by:

- Two strongly contrasting seasons, including a short rainy season of 3 to 5 months (May-September) and a long dry season (October-May) with a period of dry haze lasting up to two months (December-February);
- An average annual rainfall of around 800mm;
- Spatial variability of precipitation heights;
- Inter-annual variability with maximums greater than 1000 mm and minimums less than 600 mm;
- Variability in the distribution of rainfall throughout the year. The average annual temperature is 28.5°C with maximums of 45°C in April and minimums of 18°C in December. Relative humidity varies from 50-95% in the rainy season and 10-30% in the dry season.

2.2. The floors

Two large geomorphological groups are encountered in the region: the plain belonging to the Chadian depression and including the sandy glacis, the inselberg peneplain and the alluvial plains; the Mandara Mountains with the high altitude plateaus and mountain ranges (Donfack, 1998).

The most important soils, due to their spatial representativeness and the use made of them by farming populations, are: modal and degraded vertisols, tropical ferruginous soils and plano soils. There are also poorly developed soils and fersiallitic soils. Each of these soils has several facies linked to the state of degradation and the use made of it by humans (Seiny-Boukar, 1990).

2.3. Vegetation

There are two large groups of vegetation in the study area: periodically flooded grasslands and thorny steppes. The plant landscape is notable for the presence of isolated trees belonging mainly to the Sudanian domain.

2.4. Plant material

New Rice for Africa (NERICA) is the main planting material used. For this purpose the varieties used are: NERICA 1 (WAB 450-I-B-P-38-HB), NERICA 2 (WAB 450-11-1-P31-1-HB) and NERICA 3 (WAB 450-I-B-P-28-HB) .

These varieties come from the cross between the parents of the species *Oryza sativa* and *Oryza glaberima*.

2.5. Rice phenological data

Data collection was carried out during the plant cycle, that is to say from the seedling stage to maturation, passing through the tillering stages, panicle initiation then bolting and heading then flowering.

2.6. Seed germination and emergence

Simultaneous exit of the coleoptile; coleorhiza then simultaneous growth of the two elements. Successive emissions of different tillers, according to the tillering process of a grass (final number of tillers is a varietal characteristic).

Appearance of the initial formations of the panicle then successive elongation of the various between nodes from the base towards the top of the plant. Exit of the panicle after elongation of the last internode located immediately below its insertion.

Opening of the spikelets, exit of the stamens and fertilization of the ovules; this very fleeting stage corresponds to the anthesis and ends with the closure of the spikelets. Progressive physiological modifications of the fertilized ovum leading little by little towards the ripe grain.

2.7. Animal material

The insect (*Orseolia oryzivora*)

The adult has a pair of wings and three pairs of legs. The male measures approximately 3 mm in length, its body is tinted yellowish-brown while the female measures approximately 3.5 mm with an abdomen tinted light red. The male has a long and curved antenna while that of the female is short (Bouchard et al 1992).

2.8. Chemical materials

- ¬ Alcohol at 75°: alcohol at 75° was used to preserve samples during and after the identification of the collected specimens;
- Conservation materials
  - ¬ Cooler: the collected specimens are put in the cooler
  - ¬ Ice: it was used to preserve the samples collected from the site;
  - ¬ Fridge: it was used to store samples before identification
- Identification materials
  - ¬ Binocular magnifier
  - ¬ Insect identification keys
  - ¬ Keychain

2.9. Data collection materials

2.9.1. - Sweep net (sweep net)

The Sweep net is a net used to trap insects that live on plants (Goldstyn, 2003). There are different types of nets generally for flight catching, ground catching and mowing, but all include three parts: a circle (or hoop), a pocket (or bag) and a handle. These three parts can be adapted to specific types of hunts, for example in water or in the air.

The net used in this study is characterized by the length of its pocket which measures approximately twice the diameter of the circle. The diameter of the circle was 40 cm, the pocket approximately 80 cm and the handle was more than 1 m long. The fabric of the pocket, with its fairly fine mesh, offers little resistance to air. The net was used for mowing with rapid back and forth lateral movements. On each of the sites, the insects were captured using the "Sweep net" at the rate of 50 double mowings (100 mowings) on each of the two (02) perpendicular medians in each plot two weeks apart at from the fifteenth day after sowing until harvest.

According to Rincon-Vitova Insectaries or D-VAC Company, there are two insect catchers available: the Model 24 and the Model 122. Both are powered by motors. The insect collector used is model 122 and worn on the back.

The nets introduced for this purpose into the pipe connected to the motor accumulate air pressure at the bottom, the absorbed insects are collected more easily at the bottom of the net. D-VAC suctions were carried out on all phenological stages of the plant. It consisted of going through the plot and vacuuming up the insects by swinging the hose connected to the left motor towards the right all along the diagonal.

The advantage of sampling with the D-VAC is the more complete suction of tiny species and even large insects. It can also collect larvae and pupae. It is effective for insects living on low plants. It gives much more precise results than the mowing net, that is to say many fewer insects escape capture (Goldstyn, 2003).

On the other hand, it is often difficult to standardize this method because the devices vary in power and the efficiency can also vary depending on the user.

3. Methods

3.1. Sampling using D-VAC

During the rice crop cycle, each phenological stage of the plant is sampled every two weeks using the D-VAC vacuum cleaner and sweep net throughout the crop season given that this sampling frequency corresponded at a specific phenological stage.

3.2. Sampling technique

The D-VAC sampling methods are as follows: suction along the two diagonals of each plot. This suction consisted of traversing the plot in a diagonal direction while swinging the pipe connected to the motor from left to right.

3.3. White heart sampling and dissection technique

White hearts are sampled during the bolting stage of the plant. It consisted of randomly taking 20 feet of white hearts from two plots containing one the NERICA 1 variety and the other NERICA 2.

As for the dissection, it consisted of pushing the dissecting blade 1/3 to the level from the base of the stem. Then, the blade is slid to the end of the rod (towards the upper part) lengthwise. The stem is cut transversely and the insect is recovered this time using another blade smaller than the first. The recovered insect is either put in the petrie dish for breeding or in a test tube for conservation.

3.4. Technique for rearing *Aprostocetus sp* larvae

It consisted of:

- Collect the larvae of *Aprostocetus sp* from the stems of the attacked rice (white heart); - put them in petrie dishes containing absorbent paper (toilet paper);
- Add three drops of water every day using a scoop.

3.5. Specimen preservation technique

According to Côte (2004), insects are killed by placing them in the freezer for a few days (48 hours). So they are placed in test tubes containing 70° alcohol for conservation so that they can be identified later.

3.6. Technique for observation and identification of specimens

Observations and identifications were made at the IRAD entomology laboratory in Maroua using a binocular magnifying glass, an energy source and a Rice-Feeding insect identification key.

3.7. Determination of the number of species collected.

After this general identification, we proceeded to sort all the species collected and count them. The method used is that described in detail in the International Rice Research Institute manual (1977).

It is a method which consists of determining the number of insects in a plot during the rice development cycle. Larvae, pupae and adults were counted as representing the population of the species.

This allowed us to classify the different specimens collected into the different orders, families, genera and species and then to determine the number of each of these specimens in relation to the phenological stages of the plant. The insects responsible for rice gall, predators and parasitoids were identified among the different specimens collected.

3.8. Data analysis

Excel software was used to analyze the distribution of the African rice midge (AfRGM) population, its parasitoids and predators, taking into account the variety, phenological stage and collection method.

4. Results and discussions

4.1. Arthropods (insects and spiders) from the rice fields in the locality of Guiring.

It appears from this table below (table 1) that 34 species of insect pests belonging to 25 families distributed in 7 orders have been identified. 3 species of spiders belonging to 3 families distributed in 2 orders were also recorded.

The species of Arthropods captured and recorded in this pluvial ecosystem according to the orders are characterized as follows:

- Diptera: 4 species belonging to 4 families including those belonging to the Diopsidae and Cecidomyiidae families are recognized as being the most important pests. Hymenoptera: 5 species distributed in 4 families including the families Platygastridae and Eulophidae recognized as parasitoids respectively of the larvae and pupae of *Orseolia orizyvora*.
- Coleoptera: 8 species belonging to 6 families including Coccinelidae and Anthicidae are recognized as predators while the other families are rice pests.
- Hemiptera: 7 species distributed in 4 families, all recognized as biting, sucking pests of rice leaves, stems and panicles.
- Odonata: 2 species belonging to 2 families all recognized as predators.
- Lepidoptera: 4 species belonging to 3 families (Noctuidae, Pyralidae) all recognized as stem-boring pests.
- Orthoptera: 4 species belonging to 2 families all recognized as phytophagous pests. Spiders: 3 species belonging to 3 families, all recognized as predators.

Table 1 Number of arthropod species collected on three varieties of rice according to Classes, Orders, Family, genus and species at the Maroua farm.

				Number of arthropods		
Class	**Order**	**Family**	**Genus and species**	**NERICA 1**	**NERICA 2**	**NERICA 3**
Insecta (Hexapoda)	Coleoptera	Chrysomelidae	*Chaetocnema pulla*	5	1	2
		Coccinellidae	*Chnootriba similis*	12	4	4
			Xanthadalia effusa	24	43	32
		Apionidae	*Apion sp.*	4	6	3
			Canopion sp.	1	14	1
		Anthicidae	*Formicomus sp.*	2	11	2
		Bruchidae	*Callosobruchus sp.*	0	1	0
		Staphylinidae	*Paederus sp*	18	31	15
Insecta (Hexapoda)	Diptera	Chironomidae	*Cricotopus sylvestris*	35	77	98
		Ephydridae	*Hydrellia griseola*	32	56	45
		Diopsidae	*Diopsis thoracica*	11	21	4
		Cecidomyiidae	*Orseolia oryzivora*	18	11	34
Insecta (Hexapoda)	Lepidoptera	Pyralidae	*Nymphula depunctalis.*	12	43	4
			Maliarpha separatella	2	0	3
		Staphylinidae	*Paederus sp*	18	31	15
		Noctuidae	*Sesamia calamistis*	2	6	0
Insecta (Hexapoda)	Hymenoptera	Formicidae	*Anoplolepis sp.*	32	5	55
		Braconidae	*Xiphosomella sp.*	21	0	7

			Bracon sp.	17	33	97
		Platygasteridae	*Platygaster sp.*	7	3	18
		Eulophidae	*Aprostocetus sp*	1	5	5
Insecta (Hexapoda)	Hemiptera	Cicadellidae	*Locris ruba* Fabricius	19	6	18
			Nephotettix nigropictus	32	79	50
			Cofana spectra	22	63	80
		Delphacidae	*Sogatella furcifera*	24	15	55
			Nilaparvata lugens Stal	33	56	61
		Pentatomidae	*Diploxys sp.*	1	3	6
		Alydidae	*Leptocorisa oratorius*	3	7	5
Insecta (Hexapoda)	Odonata	Lestidae	*Lestes* sp	67	39	40
Insecta	Orthoptera	Libellulidae	*Palpopleura* sp	41	53	19
		Pyrgomorphidae	*Zonocerus varietagus*	4	9	13
			Oxylia hyla	25	16	23
		Acrididae	*Ailopus simulatrix*	6	12	16
			Acrida sp	2	7	3
Total	**7**	**23**	**33**	**537**	**759**	**825**
Arachnida						
	Araneae	Araneidae	*Araneus sp*	14	17	39
	Tetragnatidae	Tetragnatidae	*Tetragnatha sp.*	9	11	8
		Lyconidae	*Pardosa injucunda*	2	6	10
Total	**2**	**3**	**3**	**25**	**34**	**57**

The inventory of insects and spiders collected on the three varieties of NERICA in the locality of Guiring shows that the numbers of species of insects and spiders captured vary depending on the variety, the phenological stage and the method of capture.

Depending on the rice varieties and the class, we have an insect population of 537 on NERICA 1, 759 on NERICA 2 and 825 on NERICA 3 and a spider population of 25, 34 and 57 respectively on NERICA 1, 2 and 3.

On NERICA 1, 537 species of insects collected belong to 23 families distributed in 7 orders, 1 species of arachnid belonging to 1 family of the order Araneae and 2 species belonging to 2 families of the order Tetragnatidae.

On NERICA 2, 759 species of insects belonging to 23 families distributed in 7 orders, and 1 specie of arachnid belonging to 1 family and the order Araneae.

As for NERICA 3, 825 species of insects belonging to 23 families belonging to 7 orders and 1 species of arachnid belonging to 1 family and the order Araneae.

It should be noted that among the 33 species of insects collected, 8 species (*Lestes* sp, *Nilaparvata lugens*, *Cofana spectra*, *Nephotettix nigropictus*, *Anoplolepis sp, Hydrellia griseola*, *Cricotopus sylvestris*, *Xanthadalia effusa*) were encountered abundantly on all varieties.

Among its pests collected on the three (03) varieties of NERICA, the most destructive are: leaf and stem biting insects and stem borers.

In rainfed rice cultivation, all parts of the plant (roots, leaf stems, seeds) are attacked during its development cycle by numerous insect pests.

According to the capture methods (Sweep net and D-VAC Nous), a high population of pests was collected. This shows that rice is an ideal host plant for these pests and this abundance of insects can be justified either by the feeding preference of the pests towards rice throughout its development cycle or by a preference of habitat.

The density of rice vegetation during its development cycle increases, and the plant cover becomes more and more opaque and homogeneous, thus making the development conditions (temperature, humidity and lighting) of its pests favorable, this can justify this preference. habitat in this environment.

- Inventory and ecology of African rice midge (AfRGM)
- Number of African rice midge population depending on collection method.

The histograms in Figure 1 show us that the abundance of the African rice midge population varies depending on the collection method (Sweep-Net and D-VAC).

Collection using the D-VAC motor vacuum cleaner has proven to be more efficient than that carried out by the Sweep-Net because it provides us with more individuals during the entire development cycle of the plant. The maximum number of individuals collected by the two capture methods is at the tillering stage of the plant, which corresponds to that which was described in the WARDA 2006 document: “Fiel Guide and Technical Manual". While the minimum number of individuals is noted at the maturation stage of the plant.

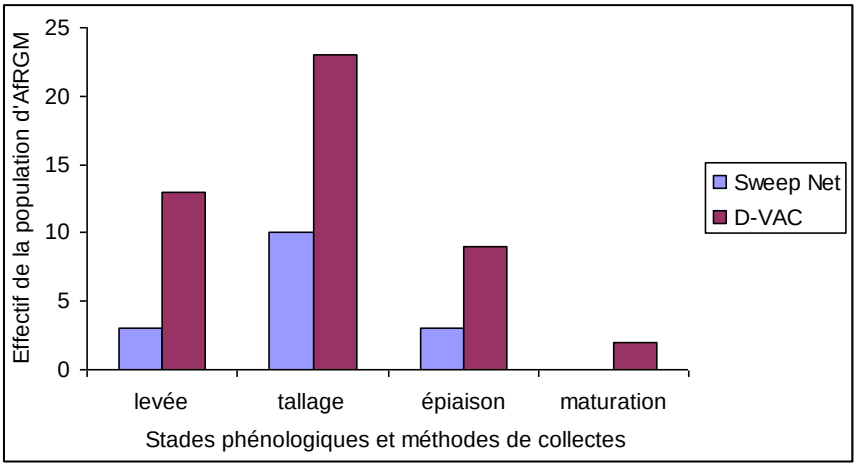


Figure 1 Number of African rice midge population according to collection method (Sweep Net and D-VAC) and phenological stage

4.2. Numbers of the afrgm population according to the collection method (sweep net and d-vac), the phenological stage and the variety of rice in the locality of Maroua.

The table 2 shows us the numbers of the African rice midge population collected according to the collection method (Sweep net and D-VAC), phenological stage and variety.

Table 2 Numbers of the AfRGM population depending on the collection method (Sweep net and D-VAC), and variety of rice in the locality of Maroua

Rice varieties	**Phenological stages and collection method**								
	emergence		tillering		heading		maturation		
	SN	DV	SN	DV	SN	DV	SN	DV	total
NERICA 1	2	4	2	6	0	3	0	1	**18**
NERICA 2	0	3	2	4	1	1	0	0	**11**
NERICA 3	1	6	6	13	2	5	0	1	**34**
Total	**3**	**13**	**10**	**23**	**3**	**9**	**0**	**2**	**63**

SN: sweep net; DV: D-VAC

It appears from this table that the collections carried out with the Sweep-Net on NERICA 1 during the emergence and tillering stage only yielded two (02) individuals each time while no individual was captured during the last two stages (heading and maturation).

As for the collection at D-VAC, it increases (4 to 6) between the first two phenological stages of the plant (emergence and tillering). When NERICA 2 was lifted, we obtained rather zero (0) individuals captured by the Sweep-Net and three (03) individuals using the D-VAC.

At heading, the two collection methods only yielded one (01) individual each time, while they were zero (0) at maturation. We have more individuals collected on NERICA 3.

The tillering stage is the stage which provides a high number of individuals for both collections (6 Sweep-Net hen individuals and 13 for the D-VAC). This was described in the WARDA 2006: Fiel Guide and Technical Manual.

Despite the abundance of this population of African rice midge on NERICA 3, the collection at the Sweep-Net is zero (0).

The histograms in Figure 2 show us the numbers of the African rice midge population according to the variety, the collection method and the phenological stage of the plant. The size of this population follows an ascending evolution from the emergence stage to the tillering stage on all varieties.

It reaches its peak during the tillering stage and drops drastically at the heading stage to be zero at maturation during collection at the Sweep –net.

It appears from these histograms that the African rice midge population is low at the emerged stage. This is justified by the fact that at the start of the dry season, that is to say after maturation, the African rice midge population decreases considerably due to the parasitism (*Platygaster sp* and *Aprostocetus sp*) and predation (*Paederus* sp) of these natural enemies and especially unfavorable environmental conditions.

Several documents have stated this, such as New Approaches to Gall Midge Resistance in Rice. IRRI, (2004), that “after the harvest, some midge larvae having escaped parasitism will survive on the rice regrowth and on other alternative hosts then At the start of the wet season after the establishment of new rice crops, the midge migrates from alternative hosts to this crop and remains at a low rate.

The abundance of the African rice midge population observed during the tillering stage is justified by the fact that during this stage the plant possesses the nutrient elements in quantity and quality for African rice midge.

A drastic decline in the population is observed during the maturation stage. This decline can be justified by the fact that the maturation period generally corresponds to the end of the rainy season and at this time, the Diptera gather in swarms near permanent pools or humid shallows (Sadou, 2008).

Their dispersion occurs with the first rains. Despite the low size of the African rice midge population according to the two collection methods, the varietal preference is clearly visible in the histograms in Figure 2.

Taking the histograms into account, we can classify the varieties in descending order of preference: NERICA 3 (13 individuals) followed by NERICA 1 (06 individuals) and finally NERICA 2 (04 individuals).

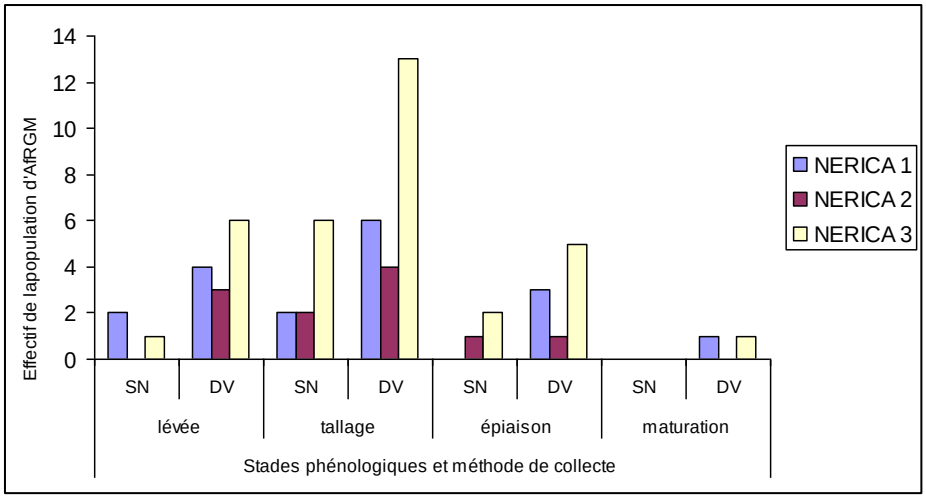


Figure 2 Number of the African rice midge population depending on the variety, the collection method and the phenological stage of the plant

4.3. Evolution of the afrgm population and its natural enemies depending on the variety and phenological stage of the plant

The histograms in Figure 3 show us that the AfRGM population evolves depending on the phenological stage of the plant and its natural enemies. As noted above, the tillering stage of rice harbors more African rice midge individuals than other phenological stages. Likewise, at this stage the population of parasitoids (*Platygaster* sp and *Aprostocetus* sp) is also important on all NERICA varieties. This would be justified by the abundance of food at this stage.

As for the predatory species (*Paederus* sp), it is present at all phenological stages of the plant but it is more important than at the emergence and maturity stages of the plant while the abundance of the African rice midge population is observed at the tillering stage.

This phenomenon could perhaps be due to the diversity of prey or to competition. At the tillering stage of NERICA 3, the population of African rice midge and that of pupal parasitoids (*Aprostocetus* sp) reach their peaks.

The population of African rice midge then falls from heading to maturity while that of *Aprostocetus* sp increases at maturity.

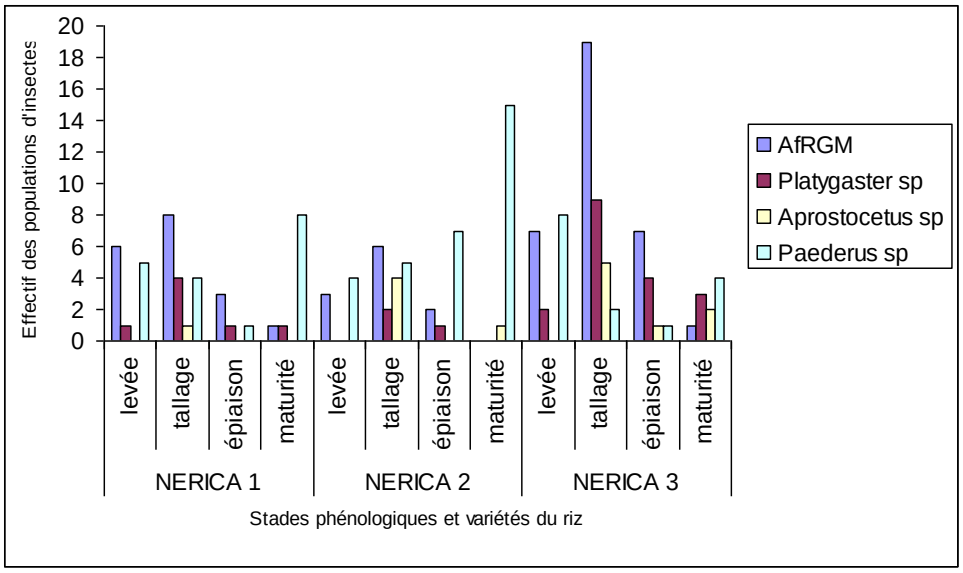


Figure 3 Evolution of the African rice midge population, parasitoids and predators depending on the phenological stage and the variety

4.4. Inventory of the population (pupae) of african rice midge and the pupal parasitoid after dissection of the white hearts in the laboratory

The table 3 shows us the number of live pupae, dead pupae 1, dead pupae 2 and empty stem after dissection of 20 white hearts of two varieties of NERICA rice (NERICA1 and NERICA3).

Table 3 Number of African rice midge pupae and *Aprostocetus sp* larvae after dissection of the white hearts.

Varieties	CV	CM1	CM2	TV
NERICA 1	4	9	5	2
NERICA 3	1	11	8	0

CV: Living chrysalis, CM1: Dead chrysalis without parasitoids; TV: Empty Stem, CM2: Dead Chrysalis with parasitoids

After the dissection of 20 white hearts per variety, it appears from this table that only 5 living African rice midge individuals were recovered out of the 38 observed.

Mortality rates of 70% and 95% are observed respectively on NERICA 1 and NERICA 3.

On NERICA1, of the 14 dead pupae, 5 had Aprostocetus sp larvae while on NERICA 3, 8 Aprostocetus sp larvae were extracted of the 11 dead pupae.

This high mortality rate is largely due to parasitism by *Aprostocetus* sp larvae and unfavorable environmental conditions during the migration of AfRGM larvae from the leaf blade to the base of the stem (Mc Colloch and Yuasa 1917). .

This may explain the drastic drop in the AfRGM population on NERICA 3 of the last three phenological stages of the plant.

Also during dissection, we observed empty stems. This may be that the chrysalis has emerged and flown away. The recovered *Aprostocetus* sp larvae are reared according to the methodology described above. From this breeding, 9 adult individuals of *Aprostocetus* sp emerged.

In general, we observed a mortality rate of 80% (Figure 4) on the dissection of the 40 white hearts of the two varieties of rice used. This percentage is approximately the same as Nwilene obtained in 2000 in the South West of Burkina Faso (i.e. more than 70% mortality) and described in “New Approaches to Gall Midge Resistance in Rice: IRRI, 2004”.

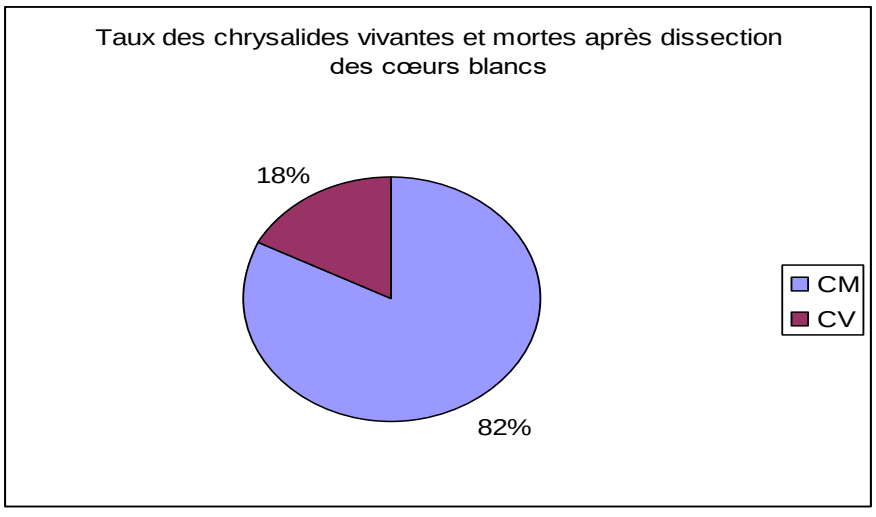


Figure 4 Percentage of live and dead pupae after dissection of the 40 white hearts

5. Conclusion

At the end of this work, we note that rainfed rice is subject to insect attacks from sowing until maturity. Among these attacks, that of midge has been threatening over the last decade.

Thus in the Maroua experimental farm, the abundance of the African rice midge population varies depending on the collection method, variety, phenological stage and natural enemies. Although D-VAC sampling is more effective, it nevertheless remains imperfect due to its noise which scares away pests during capture. The tillering stage of the plant is the one which hosts more adult individuals of African rice midge on all varieties because of its significant nutrient reserve.

The NERICA 3 variety is more sensitive than the other two varieties because it has more African rice midge population. Parasitoids evolve by following the evolution of the curve of their prey. The predatory species has diverse prey because its population peak does not coincide with that of African rice midge.

The natural enemy *Aprostocetus* sp played a large role in regulating the African rice midge population (80%) and its successful breeding confirms the hypothesis put forward by Nwilene in 2000 in the South-West of Burkina Faso. more than 70% of mortality in African rice midge population is due to natural enemies.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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