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(Research Article)

Study of insects vectors of rice yellow mottle virus in the far north region of Cameroon.

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Abstract

The present study was carried out in the research framework conducted by the Regional Center of Agricultural Research of Maroua. This investigation aimed at making an inventory of insects vectors of rice yellow mottle virus (RYMV) in the Far-North of Cameroon. The insects vectors of rice yellow mottle virus was studied in the rainfed rice ecosystem of Maroua and in the main irrigated rice ecosystems of Yagoua and Maga in the Far North Region, Cameroon. In order to attain this objective, two collection methods were used. These included collection by D-VAC (vacuum trap) and collection by the Sweep net. The collection of the insect species with the two methods was done at the different phonological stages of the rice plant (nursery, heading, booting and maturity). The insect identification key of Heinrich and the family recognition key of Delvare and al., were used to identify the different species collected. From the samples obtained in the different rice-growing sites, the dominant structure of insect vectors of rice yellow mottle as well as their natural enemies was analyzed according to the phenology of rice. It appears from the inventory of insects in irrigated rice (Maga, Yagoua) and rainfed rice (Maroua) that this crop harbors many vectors of the rice yellow mottle virus. In the different rice-growing sites, we have numbers of vector insect individuals captured of 267, 286 and 385 respectively in Maroua (rainfed rice), Maga and Yagoua (irrigated rice). The vector insects captured are distributed as follows, eight species of vector insects in irrigated rice in Maga belonging to five families divided into three orders. In irrigated rice in Yagoua, eleven species of insects vectors of RYMV belonging to seven families divided into three orders were collected. As for rainfed rice in Maroua, thirteen vector insect species belonging to seven families and three orders were collected.

Keywords: Rice; Insect Vectors; RYMV; Predators; Parasitoids; Cameroon.

1. Introduction

The second cereal in the world after wheat, by the areas devoted to it, rice is cultivated on nearly 154 million hectares. World production of paddy reached 598 million tons in 2002 (FAO, 2010). It constitutes the staple food of more than half of humanity. In the Far North province, rice growing activity has been concentrated in the Logone plains and is dominated by irrigated crops. Prospecting studies conducted by a team from the West African Rice Development Association (WARDA) in 2000 in the rice-growing areas of the irrigated perimeters of Lagdo, Maga and Yagoua showed that the yellow variegation of "RYMV" rice does indeed exist in Northern Cameroon (Awinakai, 2001). Rice yellow mottle virus (RYMV) is the main viral disease affecting rice crops in Africa (FAO, 2010).

Reckaus and al. (1997), showed that the virus is transmitted through the sap and the virus does not undergo any changes inside the insect, it just uses it as a vehicle. Affected plants have weak tillering, stunted, orange-yellow discolorationof

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leaves, panicles are deformed and do not partially emerge. In the event of a strong attack, the grains are empty. The yield losses observed vary from 64 to 100% (Traoré and al., 2001).

Arhen and al. (1983) estimated that of the 41.1% of total rice losses, 27.5% was due to insects. They are famous for the damage they cause to crops and for the diseases they carry (Brenière, 1983). Transmitted by insect vectors, the virus has spread with the introduction of productive but highly susceptible rice varieties into African rice fields and following the intensification of rice cultivation (Sy, 1994). Extremely virulent, it can destroy almost an entire harvest. Since RYMV has been known to exist in northern Cameroon, very little information has been available on the dynamics of insect vectors of the virus. To better understand the epidemiology of RYMV, more information is needed on the distribution, biology, host range, nature of damage and vector management strategies. It is for this reason that this study aims to inventory the main insect pests of rice and potential vectors of the rice yellow mottle virus.Since it became known that the rice yellow mottle virus exists in northern Cameroon, very few studies had been carried out on insect vectors and even fewer on their enemies.

According to Woin and al. (2004), four insect species transmit rice yellow mottle virus to plants in the three main irrigated rice fields at Lagdo, Maga and Yagoua in northern Cameroon and in lowland rice fields. These include *Chnootriba similis*, *Chaetocnema pulla*, *Trichispa sericea* and *Locris rubra* (Woin and al., 2004).

However, very little information is available on the list of actual rice yellow mottle virus vectors and even less on the natural enemies of these vectors. Hence the need for an in-depth study of the actual vectors of the rice yellow mottle virus in the two main types of rice-growing ecosystems (irrigated and rainfed) in the Far North Region of Cameroon, as a necessary basis for the development of a fight against these vectors.

The objective of this study is to inventory the insect vectors of rice yellow mottle virus in the rice ecosystems of the Far North of Cameroon.

More specifically, it is a question of identifying each species collected in the irrigated rice-growing areas (Yagoua, Maga) and in rainfed rice cultivation (Maroua), counting the species collected during the different phenological stages, listing among the species collected, insect vectors rice yellow mottle virus.

2. Materials and methods

2.1. Location of area

The study was conducted in Cameroon and mainly in the Far North region. In this region, the rainfed rice-growing ecosystem of Maroua (10° 30' and 11° North latitude and 14° and 14° 30' East longitude) and the irrigated rice-growing ecosystem of Yagoua and Maga (10°9' and 10°50' North latitude and 14°57' and 15°12' East longitude) were chosen, due to the important rice production activity practiced in these areas.

2.2. Plant material used

In the two rice ecosystems (rainfed and irrigated), the study was conducted on plots of 2500 m2 (dimension used by farmers). The upland rice variety used from June to September 2023 during the rainy season was Cisadane naturally infested with rice yellow mottle virus after significant colonization of the plot by insect vectors.

In the irrigated rice ecosystem on each of the Yagoua and Maga sites, the study was conducted from June to August 2023 on plots irrigated by the waters of the Logone River and the variety of irrigated rice used was IR 46 naturally infested with rice yellow mottle virus.

The two rice varieties (Cisadane and IR 46) used in this study have the following characteristics listed in Table 1.

Table 1 Characteristics of Cisadane (rainfed rice) IR 46 (irrigated rice)

Characteristics	Cisadane (rainfed rice)	IR 46 (irrigated rice)
Plant height (cm)	90	120
Sowing-heading cycle (JAS))	70-75	80-90
Sowing-maturity cycle (JAS)	95-100	100-130

Tillering	Bon	Bon
Grain length (mm)	6.9	6.9
Grain width (mm)	2.6	2.6
1000 grain weight (g)	29.0	26.0
Leaf habit	Erect	Erect
Glumelle color	Light fawn r	Light fawn
Resistance to rice yellow mottle virus	Susceptible	Susceptible
Flag leaf habit	Erect	Erect
Culinary quality	Good	Good
Coloration of apex	Black	Black
Potential yield (kg/ha)	3000	1000-3000

JAS: Day After Sowing; Source: WARDA (2000)

2.3. Insect collection equipment

A sweep net and a D-VAC aspirator were used for the collection of specimens and whose characteristics are as follows.

2.3.1. Collection using the "sweep net"

The sweep net is a net used to collect insects that live on plants (Goldstyn, 2003). The net used in this study is characterized by the length of its pocket which is approximately twice the diameter of the circle. The diameter of the circle was 40 cm, the pocket about 80 cm, and the handle was long (more than 1 m). The fabric of the pocket with fairly fine mesh, offers little air resistance.

The net was used to mow with rapid sideways movements back and forth. On each of the sites, the insects and spiders were captured using the "sweep net" net, depending on the case, at the rate of 50 double mowings (100 mowings) on each of the two (02) perpendicular medians in each plot at two weeks apart from the fifteenth day after sowing rainfed rice or transplanting irrigated rice, until harvest.

The frequency of arthropod sampling with the "sweep net" performed throughout the two-week interval corresponded to a specific phenological stage (seedling, tillering, heading and maturity).

2.3.2. Collection using the d-vac motor vacuum cleaner

According to Rincon-Vitova Insectaries or D-VAC Company, there are two insect collectors available: the Model 24 and the Model 122 (Sadou and al., 2008).

Both are powered by motors. The D-VAC insect collector used was model 122 and was carried on the back. The nets introduced for this purpose into the pipe connected to the engine accumulate air pressure at the bottom, the absorbed insects are collected more easily at the bottom of the net.

Arthropod samples (insects and spiders) using the D-VAC aspirator were taken from the fifteenth day after sowing or transplanting at two-week intervals until rice harvest on all stages. rice development.

They consisted of traversing the plot and sucking up the arthropods by swinging the hose connected to the motor from left to right. The duration of suction was about 5 minutes per plot (Sadou and al., 2008).

The frequency of arthropod sampling using the D-VAC aspirator throughout the two growing seasons corresponded to the following phenological stages: seedling, tillering, heading and maturity.

The arthropods captured by these two methods were kept in vials containing 70% diluted alcohol in order to be able to identify them progressively.

2.4. Laboratory materials

- A Dolan-Jenner binocular magnifying glass was used for observations at the IRAD entomology laboratory in Maroua during the study;
- An AIFA brand fridge was used to store the samples before identification;
- Alcohol diluted at 70% was used to preserve the samples during and after the identification of the specimens collected;
- A professional NORTEX brand digital camera was used to obtain images of certain materials and samples.

3. Specimen identification methods

A binocular loupe was used for observations at the IRAD entomology laboratory in Maroua. The insect and spider identification keys of Heinrich (1993), Hill (1983), Heinrichs and Barrion (2004) and the family recognition key of Delvare and Aberlenc (1989) were used to identify the different species. collected.

3.1. Determination of the number of species collected by sweep net and by d-vac

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

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

This allowed us to classify the different specimens collected in 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.

Insect vectors of rice yellow mottle virus, predators and parasitoids were identified among the different specimens collected.

3.2. Data analysis

Excel software was used to make a descriptive analysis of the different families of arthropods collected, taking into account the number of arthropods, the collection method and the stage of development of the rice (Sadou and al., 2008).

SAS software was used to make the correlations (verify the dependency link that exists between the numbers of rice insect pests, predators and parasitoids).

4. Results and discussions

This inventory shows that the species collected vary in abundance and quality depending on the varieties. The inventory of insects in the irrigated areas of Maga shows that the species vary in abundance and quality at the different phenological stages of rice. Also the abundance of these species at the different stages varies according to the collection methods.

4.1. Arthropods (insects and spiders) inventoried in rice-growing ecosystems

It appears from the inventory of arthropods in irrigated rice cultivation (Maga, Yagoua) and rainfed rice (Maroua), that this culture hosts species of the class of insects and species of the class of spiders (Table 2).

In the class of insects, thirty two species of insects belonging to twenty one families, divided into six orders were collected. Among them, 19 species of insects were present simultaneously in the three rice-growing sites while the other species were observed either in one site or in two sites.

On upland rice, three species of insect pests have been inventoried only in this ecosystem: *Cheilomenes lunata* (Coleoptera: Coccinellidae), *Asparavia armigera* (Hemiptera: Pentatomidae) and *Trichispa sericae* (Coleoptera: Chrysomelidae).

On the other hand, three other species of insect pests have been inventoried only in the irrigated rice ecosystem: *Recilia dorsalis* (Hemiptera: Cicadellidae), *Callosobruchus* sp. (Coleoptera: Bruchidae) and *Sesamia calamistis* (Lepidoptera: Noctuidae).

Insect species appearing in all three sites are also the most abundant compared to those appearing in only one or two sites.

In the class of spiders, four species of spiders belonging to four families distributed in the order of araneae were collected in rainfed rice cultivation and in irrigated rice cultivation.

Among them, 3 species of spiders were present simultaneously in the three rice-growing sites. The spider species appearing in all three sites are also the most abundant compared to the one that only appears in one site.

The inventory of arthropods in irrigated rice cultivation (Maga, Yagoua) and in rainfed rice (Maroua) shows that the arthropods captured vary in richness (number of species), in abundance (numbers of each species) and according to the different rice-growing sites.

4.2. The arthropods captured according to the different rice-growing sites

The table 2 presents the numbers of arthropods collected according to the rice-growing sites of Maga, Yagoua and Maroua.

Table 2 Number of arthropods collected in rainfed rice in Maroua and in irrigated rice in Maga and Yagoua

Classification of arthropods				**Number of arthropods according to rice ecosystems**		
Class	Order	Family	Genus and species	Rainfed rice	Irrigated rice	Irrigated rice
				Maroua	Yagoua	Maga
Insecta (Hexapoda)	Coleoptera	Chrysomelidae	*Chaetocnema pulla*	7	4	3
			Trichispa sericae	2	0	0
		Coccinellidae	*Chnootriba similis*	23	13	7
			Cheillomenes lunata	12	0	0
			Xanthadalia effusa	0	50	20
		Apionidae	*Apion* spp.	4	2	1
			Canopion spp.	3	13	0
		Anthicidae	*Formicomus* spp..	0	4	5
		Bruchidae	*Callosobruchus* spp..	0	0	2
		Staphylinidae	*Paederus fuscipes*	3	54	37
Insecta (Hexapoda)	Diptera	Chironomidae	*Cricotopus sylvestris*	74	175	219
		Ephydridae	*Hydrellia griseola*	105	198	227
		Diopsidae	*Diopsis thoracica*	32	110	9
		Cecidomyiidae	*Orseolia oryzae*	9	37	8
Insecta (Hexapoda)	Lepidoptera	Pyralidae	*Nymphula depunctalis.*	10	12	21
			Maliarpha separatella	1	1	13
		Noctuidae	*Sesamia calamistis*	0	12	0
Insecta (Hexapoda)	Hymenoptera	Formicidae	*Anoplolepis* spp.	27	7	64
		Braconidae	*Xiphosomella* spp.	12	0	3
			Bracon spp.	47	62	202

		Platygasteridae	*Platygaster* spp.	1	12	0
Insecta (Hexapoda)	Hemiptera	Cicadellidae	*Locris ruba* Fabricius	16	8	29
			Nephotettix nigropictus	81	90	87
			Recilia dorsalis	0	3	0
			Cofana spectra	32	106	82
		Delphacidae	*Sogatella furcifera*	24	15	35
			Nilaparvata lugens Stal	26	19	34
		Pentatomidae	*Diploxys* spp.	5	3	0
			Asparavia armigera	2	0	0
		Alydidae	*Leptocorisa oratorius*	5	14	0
Insecta (Hexapoda)	Odonata	Lestidae	*Lestes* spp.	32	67	47
		Libellulidae	*Palpopleura* spp.	44	22	116
Total	6	21	32	803	1113	1278
Arachnida	Araneae	Araneidae	*Araneus* spp.	79	103	35
		Tetragnatidae	*Tetragnatha* spp.	9	16	26
		Lyconidae	*Pardosa injucunda*	3	9	16
		Thomisidae	*Thomisus spiculosus*	0	0	2
Total	1	4	4	91	128	79

The analysis shows that the arthropods vary significantly in richness (number of species) according to the different rice-growing sites ($P<0.05$).

These captured species are distributed as follows: 27 species of insects in rainfed rice cultivation in Maroua belonging to 17 families divided into 6 orders and 3 species of spiders belonging to 3 families of the order Araneae.

In irrigated rice cultivation in Yagoua, 26 species of insects belonging to 19 families divided into 7 orders and 3 species of spiders belonging to 3 families and to the order Araneae; as for irrigated rice cultivation in Maga, 23 species of insects belonging to 17 families divided into 6 orders and 4 species of spiders belonging to 4 families of the order Araneae.

4.3. Abundance of arthropod species recorded in the different rice-growing sites

The inventory of arthropods in irrigated rice cultivation (Maga, Yagoua) and rainfed rice cultivation (Maroua) shows that the abundance of different species of insects and spiders varies significantly between rice-growing sites ($P<0.05$).

In the different rice-growing sites we have a number of insect individuals captured of: 803, 1113 and 1278 and a number of spider individuals of 91, 128 and 79 respectively in Maroua, Yagoua and Maga (Table 2).

The most abundant insect pests in the three rice-growing sites are *Nephotettix nigropictus* (Hemiptera: Cicadellidae), followed by *Cofana spectra* (Hemiptera: Cicadellidae) and *Diopsis thoracica* (Diptera: Diopsidae).

Among the least abundant pests in the three rice-growing sites, we find *Trichispa sericae* (Coleoptera: Chrysomelidae), *Asparavia armigera* (Hemiptera: Pentatomidae) and *Recilia dorsalis* (Hemiptera: Cicadellidae).

Rice is attacked by many species of insect pests. Throughout its vegetative cycle, all parts of the plant are attacked: roots, stems, leaves and seeds. Despite the high presence of secondary hosts around the rice sites (maize, sorghum and other crops and grasses), a high population of rice insect pests was collected by the two capture methods (sweep net and D-VAC).

This abundance of insects can be justified either by the food preference of pests vis-à-vis rice, or by the habitat preference of these pests. The vegetation density of rice during its development increases, and the plant cover becomes more and more opaque and homogeneous and makes the development conditions (temperature, humidity and light) of these pests favorable, this can justify this preference for habitat in this environment.

4.4. Insect vectors of rice yellow mottle virus collected from different rice-growing sites

The inventory of insect vectors of rice yellow mottle virus in the three rice-growing sites shows that the species vary in richness (number of species) and abundance (numbers of each species).

These vector species also vary according to the different rice-growing sites, according to the rice-growing ecosystems, according to the phenological stages, according to the capture methods.

It appears from the inventory of insects in irrigated rice (Maga, Yagoua) and rainfed rice (Maroua) that this crop harbors many insect vectors of the rice yellow mottle virus.

The table 3 presents the insect vector species of rice yellow mottle virus and their abundance according to the rice-growing sites.

Table 3 Number of insect vectors of rice yellow mottle virus collected in rainfed rice in Maroua and in irrigated rice in Maga and Yagoua

Order of insects	**Family**	**Genus and species**	**Number of vector insects according to rice ecosystems**		
			Rainfed rice	Irrigated rice	Irrigated rice
			Maroua	**Yagoua**	**Maga**
Coleoptera	Chrysomelidae	*Chaetocnema pulla Chapuis*	7	4	3
		Trichispa sericae Guerin	2	0	0
	Coccinellidae	*Chnootriba similis* Mulsant	23	13	7
		Cheillomenes lunata	12	0	0
Diptera	Diopsidae	*Diopsis thoracica*	32	110	9
Hemiptera	Cicadellidae	*Locris ruba Fabricius*	16	8	29
		Nephotettix nigropictus	81	90	87
		Recilia dorsalis Motschulsky	0	3	0
		Cofana spectra	32	106	82
	Delphacidae	*Sogatella furcifera* Horvath	24	15	35
		Nilaparvata lugens Stal	26	19	34
	Pentatomidae	*Diploxys* spp.	5	3	0
		Asparavia armigera	2	0	0
	Alydidae	*Leptocorisa oratorius*	5	14	0
Total	7	14	267	385	286

The table 3 shows that fourteen species of insect vectors of rice yellow mottle virus (RYMV) are associated with rice cultivation in the study area.

Among them, eight species were present simultaneously in the three rice-growing sites while the other species were observed either in one site or in two rice-growing sites.

The species appearing in the three rice-growing sites are also the most abundant compared to those appearing in only one or two sites.

In the different rice-growing sites, we have numbers of vector insect individuals captured of 267, 286 and 385 respectively in Maroua (rainfed rice), Maga and Yagoua (irrigated rice).

The vector insects captured within the framework of this study are distributed as follows: eight species of vector insects in irrigated rice in Maga belonging to five families divided into three orders; in irrigated rice in Yagoua, eleven species of vector insects belonging to seven families divided into three orders; in rainfed rice on in Maroua, thirteen species of vector insects belonging to seven families and three orders.

Indeed, rainfed rice in Maroua has the largest number of vector species, i.e. thirteen vector species, than the irrigated rice-growing sites of Yagoua where eleven vector species were collected and in Maga where eight species were collected.

This shows that the rice-growing sites of Maroua, Maga and Yagoua constitute a favorable environment for the development of these insect vectors.

Among the insect species captured in abundance in Maroua, Maga and Yagoua, the beetle order is represented by *Chnootriba similis* (Coleoptera: Coccinellidae) and *Trichispa sericae* (Coleoptera: Chrysomelidae).

Indeed, *Chnootriba similis* (Coleoptera: Coccinellidae) and *Trichispa sericae* (Coleoptera: Chrysomelidae) are defoliators and transmit the rice yellow mottle virus to the plant during their feeding.

Chnootriba similis (Coleoptera: Coccinellidae) and *Trichispa sericae* (Coleoptera: Chrysomelidae) had been studied in an insectary by Abo and al. (2004), to determine their ability to transmit rice yellow mottle (RYMV). The latter showed that *Chnootriba similis* Thunberg is a phytophagous lady beetle and transmitted the variegation (RYMV) in the insectarium test in a semi-persistent manner.

Chnootriba similis and *Trichispa sericae* are reported for the first time in this study as vectors of rice yellow mottle virus (Abo and al., 2004).

In addition to the presence of insects of the order Coleoptera, insects of the order Hemiptera were also collected. Indeed, in the three rice-growing sites, three species of vector insects were captured in the three rice-growing sites: *Nephotettix nigropictus* (Hemiptera: Cicadellidae), *Cofana spectra* (Hemiptera: Cicadellidae) and *Sogatella furcifera* (Hemiptera: Delphacidae).

These species were much more important in the two irrigated rice cultivation sites than in the rainfed rice cultivation site where few individuals were collected.

Grist et al. (1969), also showed that all the Hemiptera captured within the framework of this study*: Nephotettix nigropictus* (Hemiptera: Cicadellidae), *Cofana spectra* (Hemiptera: Cicadellidae) and *Sogatella furcifera* (Hemiptera: Delphacidae) are vectors of viruses, in particular the rice yellow mottle virus.

Indeed, these insects, thanks to their biting and sucking mouthparts, inoculate the virus into the plant through the sap during their nutrition.

As for the order Diptera, a species of vector insects was captured: *Diopsis thoracica*. It was much more abundant in irrigated rice cultivation in Yagoua only.

Indeed, *Diopsis thoracica* (Diptera: Diopsidae) being stem borers transmit rice yellow mottle virus to plants through wounds (Bakker, 1974).

According to Bakker (1974), transmission of rice yellow mottle virus is the result of mechanical injury caworn by *Diopsis thoracica* and which contaminate the plant with the virus during their nutrition.

5. Conclusion

Different species of insects attack rice and these insects are considered as potential vectors of the yellow rice mottle. the rapid proliferation of the yellow rice mottle constitutes a serious threat to the continuation of the effort to intensify rice cultivation and therefore to the sustainability of the system.

The inventory of insect vectors of the rice yellow mottle virus carried out in the rainfed rice-growing ecosystem and in the irrigated rice-growing ecosystem of the Far North region has made it possible to list several vector species of the order Coleoptera , Hemiptera and Diptera dependent on these ecosystems.

Fourteen vector species included in seven families and distributed in the three orders were collected on upland rice and irrigated rice.

The insect vectors captured were much more numerous in the two irrigated rice sites than in the rainfed rice site.

Among the vector insect species captured in abundance in Maroua, Maga and Yagoua, the beetle order is represented by *Chnootriba similis* (Coleoptera: Coccinellidae) and *Trichispa sericae* (Coleoptera: Chrysomelidae).

The insect vectors of the order Hemiptera captured are: two species of insect vector from the family of cicadellidae *Nephotettix nigropictus* (Hemiptera: Cicadellidae) and *Cofana spectra* (Hemiptera: Cicadellidae) and one species of insect vector from the family of Delphacidae *Sogatella furcifera* (Hemiptera: Delphacidae). As for the order Diptera, a species of vector insects was captured: *Diopsis thoracica*.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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