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IMPACT OF INSECT PEST ON YIELD OF RICE: CASE OF VARIETIES IR 46 AND NERICA 3 IN AGROECOSYSTEME OF MAGA FAR NORTH OF CAMEROON

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Abstract

This present study which is base on the effect of pest insects on the production of rice was done in the Far North Cameroon in the irrigated rice ecosystem of Maga. On one part, it consisted of the determination of the biological diversity of pest insects of rice in the rice ecosystem of Maga, to evaluate the damages and the dynamism of pest insects on the phenologic stage of rice and on the other part and to evaluate the effect of insecticide lynx on the pest insects and the production of rice. A split plot disposition of two rice varieties (irrigated rice variety IR 46 and the rainy season rice variety NERICA 3) and two treatments (control and chemical treatment) were adopted. The insects were captured with the help of a sweep net on every portions on the phenologic stages of rice, from the 15th day after planting to harvesting. This method of collecting insects consists of sweeping insects, on the portions or 50 sweeps per portion. These collections of pest insects on the two rice varieties have permited us to see the dynamism of pest insects on the different phenological stages of rice, and a knowledge on their abundance. The results obtained on the biological diversity have shown that 2465 pest insects of rice were collected on the IR 46 variety and 3264 on the NERICA 3 variety. Concerning the dynamism of the pest insects, we have observed a variation of the number of pest insects following the different phenological stages of rice. Concerning the damages due to the pest insects, lose due to these pest insects was evaluated at 49.98% total, 26.30% lose at the talling stage and 23.68% at the harvest on the two varieties. The chemical insecticide lynx have reduced the pest at a rate of 12.585% in the nursery, 20.4725% at the talling stage, 9.305% at the ear and 8.7325% at maturity. The output was obtained at 2.13 t/ha for the IR 46 variety and 1.91 t/ha for the NERICA 3 variety. This result permits us to say that many pest insects occupies the irrigated rice ecosystem of Maga, they are dynamic and leads to the damages on the rice production. The insecticide lynx used permit the reduction of the pest insects and hence increasers production.

Key words: Rice, varieties, pest insects, damage, chemical fight, effects, Maga.

Introduction

1.1. Context

Rice (*Oryza* sp.) is the base aliment of over half of the population of the globe (Guigaz, 2002). It represents more than 25% of the total consumed grain, it place second behind wheat (Patricio Mendez del Villar, 1993). In West Africa, rice consumption is more important. It represents 60% of total consumption in sub-Saharan Africa. Despite the progress observed through the extension of cultivated areas and the increase in yields, local production only covers 60% of the consumption needs (Patricio Mendez del Villar, 1993).

Rice is a master culture for growth and the strengthening of food security in several countries. In Africa, great efforts are committed to increase the irrigated rice cultivation surfaces in order to increase the yield, while the rain fed rice moved gradually where rain and soil conditions are favorable for its production. Thus the research for good productivity is in rhyme with the use of fertilizers, the choice of resistant, more productive varieties, well adapted to the environmental conditions and especially a better plant protection to crops (Alain Audebert, 2015). |

In Cameroon, the national rice production increased from 738 187 642 tonnes in 2012 to 745 709 798 tonnes in 2013 thus an increase of 7 522 156 tons (FAOSTAT, 2013). Domestic consumption is 2-13 kg/year/habitat but despite this increase of the production.

The national production needs are covered (FAO, 2010). Imports increased from 21000 tonnes in 1975 to 300 000 tonnes in 2010 (AGRI-STAT, 2012). To fully cover the national demand, Cameroon must import 400,000 tonnes of rice (FAO, 2006). Rice production has been essentially driven by the State, through the establishment of the expansion and modernization rice company of Yagoua (SEMRY) and the southern rice development company of the plains of Mbos (SODERIM) and "Upper Noun Valley Development Authority" (UNVDA) (Engola, 1991).

The expansion and modernization rice company of Yagoua (SEMRY) covers an area of approximately 11 518 hectares, representing more than half of the irrigated land and provide alone at least 90% of the national production (FAO, 2013). Rice is produced at the far North Cameroon in two types of ecosystems that are rain-fed rice cultivation and irrigated. This rice production suffers especially from many diseases and insect pests attack problem

1.2. Problem

In the Far north Region of Cameroon, rice cultivation is faced with several problems, namely the problem of soil infertility, drought, seed yield problems, diseases and insect pests, resulting in the instability of the performance of rice production.

Among all these problems, those caused by insect pests are the most feel and the most formidable. Today, we notice that insect pests pose a very serious threat in the progress to improve rice production and other cultures. These insects have become famous by their damage and are the main rivals of man, due to their very large number in the animal Kingdom.

In order therefore to improve the productivity of rice in the region of the far North in particular in irrigated rice ecosystem of Maga and promote sustainable production of rice in dry season (irrigated rice), this study is designed to improve production of rice by the management of insect pests.

1.3. Objectives

In this study, the main objective is to improve production of rice by proper management of insect pests of rice in the rice-growing ecosystem of Maga in the far North Region of Cameroon.

To achieve this objective, specific objectives have been developed:

- Determine the biodiversity of insect pests of rice in the rice-growing ecosystem of Maga;
- Give the dynamics of insect pests on the phenological stages of rice in the rice-growing ecosystem of Maga;
- Estimate damage to insect pests of rice in the rice ecosystem Maga;
- To evaluate the effect of the insecticide lynx on insect pests and yield of rice in the rice-growing ecosystem of Maga.

2.1. Presentation of the study areas

The study was conducted in the irrigated rice area of the expansion and modernization of the rice company of Yagoua (SEMRY) on the site of Maga. Maga is located in the Mayo-Danay, division, far north region and between 10 ° 9' and 10 ° 50' latitude North and 14 ° 57' and 15 ° 12' longitude East.

2.2. Materials

2.2.1. Biological materials

The test focuses on the study of variety of rice *Oryza* sp. The two varieties of rice used are NERICA 3 and the IR 46. These two varieties are characterized on the following table.

Table 2: Characteristics of upland rice (NERICA 3) and irrigated varieties (IR 46)

Characteristic	NERICA 3	IR 46
Heigth of plant (cm)	70	120
Cycle of planting-epiaison (DAP)	50-65	80-90
Cycle of maturity (DAP)	80-90	100-130
Talling	Good	Good
Length of grain (mm)	6.9	6.9
Largeness of grain (mm)	2.6	2.6
Weigth of 1000 grains (g)	29.0	26.0

DAP : Days After Planting
Source : ADRAO, 2000.

2.2.2. Chemical material

The test was implemented in the basic plots of 28 m² (7 m x 4 m), chemical control was applied on two varieties of rice (IR 46 and NERICA 3) to evaluate its effectiveness and its rapidity in the fight against insect pests of rice. Two types of treatments will be used to conduct this study: a parcel of rice that will be treated with the insecticide lynx, a control plot where no control method was used for the fight against insect pests of rice. The lynx insecticide has been used to test the effect on insect pests of rice and was sprayed every fifteen days in the plots of rice which will receive this treatment (processed rice).

2.2.2.1. Spectrum of action and target of the product

The lynx insecticide is registered to fight against several insects, including beetles, butterflies and moths, flies, lice, mites, sawflies, crickets, earwigs, grasshoppers, centipedes, pill bugs, thrips, ticks and cockroaches. Lynx is also approved for the vegetable, food, fruit and floral pests. The acetamypride which is one of the components of the active material act against the insects found on vegetation after spraying.

2.2.2.2. Product Description

Common or trade name: Lynx
Usefulness: Insecticide
Chemical family: Pyrethroid (organic Insecticide of biological origin)
Active ingredient: Lamida-cyhalothrin 15 g/l + 20 g/l EC Acetamiprid**.**

2.2.2.3. Application of insecticide lynx

The dose is 1 l lynx/ha or 50 ml for a backpack sprayer of 15 liters of porridge, for a surface of 500 m². The dose was applied for our study was 2.8 ml diluted into 0**,**84l for a surface of 28 m^2. Spraying of the insecticide lynx in the basic plots occurred early in the morning for best results. The interval of treatments was 15 days.

2.2.3. Collection material of insects

"Sweep net" constitute the principal collection material of insects which its characteristic is as follows.

2.2.3.1. The "Sweep net"

The "net sweep" is a net that is used to collect insects that live on plants (Goldstyn, 2003). There exist generally different types of nets for capturing in flight, capture on the ground and mowing, but all consist of three parts: a circle (or RIM), a Pocket (or purse) and a handle. These three parts can be adapted to specific hunts types, for example in the water or in the air. The net used in this study is characterized by the length of his pocket which is approximately twice the diameter of the circle. The diameter of the circle was 40 cm, Pocket about 80 cm and the handle was long (more than 1 m). The Pocket has quite fine-mesh fabric, offering little resistance to air. The net was used for mowing by Rapids lateral movements of comes and goes. On each of the basic plots, insects were captured using sweeps ("sweep net") with 25 double sweeps (50 sweeps) on elementary plots from the fifteenth day after planting or transplanting, until the harvest.

2.4. Methods

2.4.1. Experimental dispositive

The experimental device used in our experiment is a device in split-splot, it consisted of allocation of treatments on experimental units by randomization. In this device, there is no control of heterogeneity factor to take into account so it is done without visible heterogeneity gradient. The experimental apparatus consists of three blocks divided into elementary plots of 7 m x 4 m; in each block, there are two types of treatments (chemical control and control) were applied on two varieties of rice (IR 46 and NERICA 3) with three repetitions. Between the elementary plots we had a spacing of 1 m in width and between the blocks 2 m wide (see annex 1).

2.4.2. Sampling of insects after insecticide application

2.4.2.1. "Sweep net"

On each elementary plot regardless of the treatment applied to the basic plot, insects will be caught using net "sweep net". In elementary plots 25 double sweeps (50 sweeps) are applied to insect pests following the phenological stages of rice. Mowing is done early in the morning to better capture insects that make rice plants their huts and their biotopes. After mowing, we closed the Pocket so that the captured insects cannot escape, then are removed from the pocket of the circle of the sweep net and label at once then attached to prevent insects from escaping. The same process is done to all the experimental plots.

2.4.2.2. Period of insects collection

The sampling is carried out in the nursery, talling, heading and maturation of seeds. Their characteristics are reflected in the table below.

Table 3: Characteristics of the phenological stages of rice

Phenological stages	**Phenological characteristics of rice**	**Period of insect collection (DAP)**
Nursery	Germination of grains and kick off; simultaneous outbreak of coleoptiles of coleorhize then simultaneous growth of two element.	15
Talling	Successives emissions of different tales, according to process of talling of a grain (The definite numbers of tales is a varietale characteristic).	30-45-60
Epiaison then flowering	Outbreak of panicles after elongation of node situated below its insertion. Opening of epiellets, outbreak of etamines and fertilization of ovules, this stage is very fugage, correspond to the anthers then end with closing of epillet.	75-90

Maturation of grains	Progressive physiological modification of fertilized ovule following small by small toward grain wall. Successive emissions of different tillers, according to a grass tillering process (the final number of tiller is a varietal characteristic). Output of the panicle after elongation of the internode immediately beneath its insertion. Opening of the spikelets, output of stamens and fertilization of the ova; This very fleeting stage corresponds to anthesis and ends with the closing of the spikelets. Progressive physiological changes of the fertilized egg leading gradually towards the ripe grain.	100

DAP : Days After Planting
Source : Pollet (1974)

2.4.2.3. Observation and identification of specimens

Keys for the identification of insects from Heinrich (1993), Hill (1983), Heinrich and Balaji (2004), the recognition keys of the family of Delvare and Abbasi (1989) on rice pests were used to identify the different collected species.

2.4.3. Dynamics of insect pests on the phenological stages of rice in the rice-growing ecosystem of Maga

The dynamics of the insect pests of rice was made count of insect pests after collection and identification on the plots following the different phenological stages; taking account of the varieties used (IR 46 and NERICA 3). Then the totals per insect pest, variety and by phenological stage of rice allowed us to represent histograms by species on order to see the dynamics of each species.

2.4.4. Measures

The larvae, pupae and adults will be counted and represent the strength of the species on each variety, depending on the treatments. This allowed us to classify various specimens collected in different orders, families, genera and species and then determine the number of each of these specimens compared with the growth of the plant stages and treatment.

3.1. Data analysis

Data collected during the study were searched manually. After the manual recount, they were entered into the Excel software and submitted to analysis of variance using the STATGRAPHICS. Averages will be compared using Student's test at the 5% probability level. Thus, we have presented the tables, figures, curves and various diagrams.

3.2. Estimation of damage on the culture of the rice in the rice-growing ecosystem of Maga

3.2.1. Estimating the damage due to borers at harvest time

The methodology for this evaluation is that of Benniere (1982). Fifteen days before the beginning of the harvest, we collected 20 clumps of rice on each elementary parcel to be examine. Sampling is done randomly. To do this, simply stretch a rope with knots spaced all across the rice fields of 2 m. Removed the nearest clump of each node. All stems carrying panicles are separated from each other, until we get a total of 200 stems. We opens then each stem with a penknife, and are classified in:
-Panicles without attacks from borers in the stem: n1;
-Panicles with attacks of borers in the stem (insects present or not): n2.
After threshing of grains of each batch, we get:
-P1: weight of n1;
-P2: weight of n2.

On the same location, estimated the number N of panicles per square meter. To do this, we use a rigid framework of 1 m² put randomly on the ground (do ten repetitions to get an average value). The following formula expresses with a fairly good approximation (by weight of grain per hectare) loss due to attacks by drillers from the heading:

$$P = \frac{200\frac{p_1}{n_1} - (p_1 + p_2)}{200} \times 10\,000\ N$$

P = loss in weight of grain per hectare;
N1 = panicles without attacks from borers in the stem;
N2 = panicles with attacks of borers in the stem (insects present or not);
P1 = n1 weight;

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P2 = weight of n2;
N = number of panicles per square meter.

This data can then be converted into monetary value. There will be much care to bring in category n1, stems whose panicles will be altered by other causes than drillers (blast of the neck for example). If their number is too important, the benefit expected by the fight against the drillers would be reduced. Note that this method of calculation does not take account of losses (dead hearts) during talling, because of these inaccuracies, this assessment underestimates the actual loss in general. It can therefore be regarded as a minimum, use for the study of profitability fight.

3.2.2. Estimating damage from insect pests during talling

To achieve this, it was noted on each parcel:
-Nt: average number of fruiting stems per meter square on witnesses parcel;
-N: average number of fruiting stems per meter square on treated parcels.
These values are obtained by averaging few surveys (at least five) conducted at random in each plot by using a rigid framework of 1 m². On the other hand, surveys intended for the assessment of loss of harvest due to the stem borers after talling was conducted (using the above method) on couples plot, the formula indicates the loss before bolting

$$P_a = \frac{P_1}{n_1} \times 10\,000\ (N - Nt)$$

n_1 = number of stems without attacks by insects drillers
p_1 = weight of grain n_1
p_a = loss of crop due to insects acting before bolting.

Applied to each control plot, this formula is used to calculate the average value of Pa of all couples (treated and untreated plots) representative of the rice-growing perimeter. The expected results will be reliable if the area concerned is relatively homogeneous and if we are not found in the presence of certain pests that are characterized by heterogeneous infestations: sampling, then, is more really representative of reality.

3.3. Evaluation of the production of rice in the ecosystem of Maga

In this part we will use the formula of Marc Lacharme used in 2001.

- **Rice yield components**

The rice crop yields (RYC) is the production of grains per unit area. II is usually given in quintals per hectare or tonnes per hectare. The objective of any producer is to maximize performance at an acceptable economic cost. The rice yield assessment takes into account several components namely: the number of plants per hectare (NP/ha or NP/m2 (10,000), the number of tallers/feet (NT/P), the number of panicle/taller (postal code/T), the number of grain/panicle (NG/Pa) and the weight of a grain (PG). This performance can be broken down into different components according to the following formula:
With: RYC = NP/ha x NT/P x Npa/T x NG/Pa x PG
RYC = Production/ha
NP/ha or NP/m2 (10,000 m2) = number of plants per hectare
NT/P = number of tillers/feet
Postal code/T = number of panicle/taller
NG/Pa = number of grain/panicle
PG = weight of a grain.

4. Results and Analysis

4.1. Specific diversity of insect pests and auxiliaries of rice in the Maga ecosystem

23 species of insects belonging to 7 orders, 19 families have been collected. In the class of spiders, 2 species of spiders belonging to 2 families in the order of Araneae were collected in the ecosystem of Maga.

In the class of insects and inventoried Arachnida, we had grouped the species in order, family, genus and species, the order found are as follows:
-Diptera: seven species in six families are identified; the family of the Diopsidae is recognised as being the pest (borers).
-Hemiptera: three species belonging to three families are identified; they are the piercing-sucking.
-Coleoptera: five species have been identified and the Coccinellidae families are recognized as predators while other families are pests of rice.
-Lepidoptera: two species of the families Noctuidae and Pyralidae are identified and recognised as pests of rice borers.
-Hymenoptera: in this order, two species are identified.
-Odonata: two species in two families all of whom are predators.
-The Orthoptera: here two species have been identified.
-Araneae: spiders order we had two species belonging to two families who are predators.
Insects Inventory and spiders captured in Maga ecosystem shows that these arthropods and spiders vary in number and species according to the phenological stages of rice.

4.1.2. Inventory of insect pests following phenological stages of rice

4.1.2.1. Nursery

The table 4 indicate insect pests inventoried at nursery stage in rice site of Maga

Table 4. Insect pests inventoried at nursery stage in rice site of Maga.

Order	Families	Gender/Species	Effectiveness of insect pest by varieties	
			IR 46	NERICA 3
Diptera	Otitidae	*Physiphora clausa F*	84	95
	Culicidae	*Culex robinotus*	183	176
	Micropezidae	*Glyphodera mantis*	197	212
	Diopsidae	*Diopsis sp*	05	04
	Syrphidae	*Paragus dolichorus*	07	00
Coleoptera	Lagridae	*Lagria gesquierie*	00	01
	Coccinellidae	*Cheilomenes lunata*	00	01
	Staphylinidae	*Paederussabaeus*	00	01
Hemiptera	Cicadellidade	*Nephottetix nigropictus*	48	57
Lepidoptera	Pyralidae	*Sesamia calamistis*	00	01
Total : 4	**10**	**10**	**524**	**548**

It appears from this table that the insects on rice in nursery are divided into 4 orders, 10 families and 10 species of insects. The most represented is the order of the Diptera with 5 species *Culex robinotus*, *Physiphora clausa* F, *Glyphodera mantis*, *Diopsis* sp and *Paragus dolichorus*; the order of Coleoptera comes with 3 species *Lagria gesquierie*, *Cheilomenes lunata* and *Paederus sabaeus*; the order of Lepidoptera comes with 2 species; the order of Hemiptera and Hymenoptera are represented to them by a species.

In the nursery the most abundant species are *Glyphodera mantis*, *Culex robinotus* and *Physiphora clausa* F all belong to the order Diptera that are biting the nozzles or the stem borers; at this stage the damage on plants are not too accentuated except a few taches and perforation on the leaves.

4.1.2.2. Talling

Table 5 shows the strength of the insects collected at the stage of talling in rice site of Maga.

Table 5: Insects collected at the stage of talling in rice site of Maga.

Order	Families	Gender/species	Effectiveness of insect pest per varieties	
			IR 46	NERICA3
Diptera	Otitidae	*Physiphora clausa F*	369	364
	Culicidae	*Culex robinotus*	162	217
	Micropezidae	*Glyphodera mantis*	279	526
	Diopsidae	*Diopsis sp*	43	23
Coleoptera	Lagridae	*Lagria gesquierie*	03	04
	Coccinellidae	*Xanthadalia effusa*	02	06
Hemiptera	Cicadellidade	*Nephottetix nigropictus*	109	296
Lepidoptera	Pyralidae	*Maliarpha separatella*	04	10
	Noctuidae	*Sesamia calamistis*	01	01
Total : 04	**09**	**09**	**972**	**1447**

Table 5 shows that insects and spiders captured on rice at talling stage are divided into 04 orders, 09 familles and 09 species distributed in 04 orders and 09 families. The Diptera is the most represented order with 4 species (*Physiphora clausa* F, *Glyphodera mantis*, *Culex robinotus* and *Diopsis* sp) followed by the order of Coleoptera (with 2 species *Lagria gesquierie, Xanthadalia effusa*), Lepidoptera come with *Sesamia calamistis* here. The order Hymenoptera and Hemiptera as for them are each represented by a species.

Among these insects, *Physiphora clausa* F rice fly species is the most represented with an average of 0.33 on the IR 46 variety and an average of 0.25 on NERICA 3. An observation on the analysis of averages per variety lets us say that the NERICA 3 variety is more attacked by insect pests; This is explained by the fact that this variety is much more cultivated in the rainy season and behaves as well in rain and irrigation system. The results of the different collections show us that the is more insects in nursery on IR 46 compared to talling.

At the beginning of the cycle of talling the most felt and most visible damage are caused by sucking sewers that leaves transparent white spots on the leaves of rice. Stem borers penetrate stems, create their galleries and damage internal tissue thus causing dryness and the death of the central part of the stalks or heart in which in the end gives white and empty panicles. These much damage are caused by the larvae of *Maliarpha separatella* and *Sesamia calamistis* which are Lepidoptera on rice; There is also the case of Diopsis SP. (Diptera). These stem borers are the main enemies of rice, including the genus Chilo (that we had not been able to meet) is the most economically important pest (Saliou DOLMA, 1986). The combined effect of these types of damage resulted in yield losses which were estimated to be about 25% of the harvest in intensive culture (VERCAMBRE, 1979) cited by Saliou DOLMA, 1986.

4.1.2.3. Heading

Table 6 presents insect pests inventoried at the heading stage of rice in site of Maga.

Table 6: Insect pests inventoried at the heading stage in rice Maga site

Order	Families	Genders/Species	Effectiveness of insect per varieties and treatment.	
			IR 46	**NERICA 3**
Diptera	Otitidae	*Physiphora clausa F*	255	413
	Culicidae	*Culex robinotus*	15	15
	Micropezidae	*Glyphodera mantis*	182	260
	Syrphidae	*Allongnota nasuta* Macqueat	01	00
	Diopsidae	*Diopsis sp*	21	15
Coleoptera	Staphylinidae	*Paederus fuscipes* Curtis	00	01
	Coccinellidae	*Cheilomenes lunata*	01	00
	Coccinellidae	*Xanthadalia effusa*	05	00
Hemiptera	Cicadellidade	*Nephottetix nigropictus*	111	129
	Alydidae	*Stenocoris clariformis*	01	00
Hymenoptera	Braconidae	*Apanteles rufierus*	06	03
Lepidoptera	Pyralidae	*Maliarpha separatella*	18	24
	Noctuidae	*Sesamia calamistis*	06	04
Orthoptera	Tettigoniidae	*Conocephalus maculatus*	07	04
	Avididae	*Cussyrtus bivittatus*	00	01
Total : 06	**14**	**15**	**629**	**869**

Table 6 shows us that insects and spiders captured on the rice heading stage belong to 07 orders, 14 families and 15 species. The Diptera is the order most represented with 5 species (*Physiphora clausa* F, *Glyphodera mantis*, *Culex robinotus*, *Diopsis* sp and *Allongnota nasuta* Macqueat) followed by the order of Coleoptera with 4 species (*Xanthadalia effusa*, *Apion africanum*, *Paederus fuscipes* Curtis, *Cheilomenes lunata*), Lepidoptera come with 2 species *Sesamia calamistis* and *Maliarpha separatella*. There is the appearance of the *Stenocoris clariformis* species in the order Hemiptera, *Allongnota nasuta* Macqueat in the order Diptera; the order Hymenoptera and Orthoptera which did not appear in the nursery and talling appear with the species *Apanteles rufierus* (Hymenoptera), *Conocephalus maculatus* and *Cussyrtus bivittatus* which belong to the order Orthoptera.

At the heading stage, the most visible damage are those caused by sucking sewers (*Nephottetix nigropictus*) that leave transparent white spots on the leaves and stem borers the that penetrate stems, eat internal tissue causing dryness and the death of the central part of the stems called death heart giving white and empty panicles (Abou Togola, 2010).

4.1.2.4. Maturity

Table 7 presents insects and spiders inventoried at the mature stage of rice in Maga site.

Table 7: Insects and spiders inventoried at the stage of maturity in the rice-growing site of Maga

Order	Families	Gender/Species	Effectiveness of insect per varieties and treatment	
			IR 46	**NERICA 3**
Diptera	Otitidae	*Physiphora clausa F*	14	33
	Culicidae	*Culex robinotus*	07	10
	Micropezidae	*Glyphodera mantis*	01	16
	Diopsidae	*Diopsis sp*	43	34
	Syrphidae	*Microdon jahanna*	00	01

	Syrphidae	*Paragus dolichorus*	00	01
	Syrphidae	*Allonggratanasuta* Mcqueat	01	03
Coleoptera	Apionidae	*Apion africanum*	01	00
	Coccinellidae	*Xanthadalia effusa*	03	04
Hemiptera	Pentatomidae	*Agonocelis harolldi* Beigs	00	01
	Alydidae	*Stenocoris claviformis*	00	01
	Cicadellidade	*Nephottetix nigropictus*	12	13
Hymenoptera	Braconidae	*Bracon sp*	03	00
	Braconidae	*Apanteles ruferierus*	16	03
Lepidoptera	Pyralidae	*Maliarpha separatella*	01	00
	Noctuidae	*Sesamia calamistis*	00	02
Orthoptera	Tettigoniidae	*Conocephalus maculatus*	238	278
Total : 06	**15**	**17**	**340**	**400**

The insects collected at the stage of maturity of rice has 06 orders (Diptera, Coleoptera, Hemiptera, Lepidoptera, Orthoptera, Hymenoptera) were the orders of Diptera is the most represented with 7 species (*Physiphora clausa* F, *Culex robinotus*, *Glyphodera mantis*, *Diopsis* sp, *Microdon jahanna*, *Paragus dolichorus*, *Allonggrata nasuta* Macqueat). In the order of coleoptera we had identified 3 species (*Cheilomenes lunata*, *Apion africanum*, *Xanthadalia effusa*) and note the disappearance of species *Paederus fuscipes* Curtis and *Lagria gesquierie* at the stage of maturity. The order of Hemiptera comes with two new species *Agonocelis harolldi* Beig and *Diploxys* sp. But we note that in the order Orthoptera species *Conocephalus maculatus* had a high number of insects compared to others.

4.2. Diversity of predators following phenological stages of rice

Table 8 presents predators inventoried according to the phenological stages of rice in Maga site.

Table 8: Predators inventoried according to the phenological stages of rice in Maga site

Order	Families	Genders and species	Nursery	Talling	Heading	Maturity
Arachnida	Araneidae	*Araneus* sp	01	10	64	00
	Tetragnatidae	*Tetragnatha sp.*	38	20	04	08
Diptera	Syrphidae	*Paragus dolichorus*	*07*	00	00	01
	Syrphidae	*Allongnota nasuta* Macqueat	00	00	02	05
	Syrphidae	*Microdon jahanna*	00	00	00	01
Odonates	Lestidae	*Lestes sp.*	47	115	72	15
	Libellulidae	*Palpopleura sp.*	00	05	07	10
Coleoptera	Coccinellidae	*Xanthadalia effusa*	00	08	07	10
	Coccinellidae	*Cheilomenes lunata*	01	00	02	00
	Staphylinidae	*Paederus sabaeus*	00	00	00	01
	Staphylinidae	*Paederus fuscipes* Curtis	00	01	01	00
Orthoptera	Tettigoniidae	*Conocephalus maculatus*	00	00	11	1201
hymenoptera	Braconidae	*Apanteles rufierus*	00	00	35	36
	Braconidae	*Bracon sp*	03	04	00	02
Total	**8**	**12**	**97**	**163**	**205**	**1290**

It is from this inventory that eleven predatory species included in two classes divided into six orders and eight families have been collected on irrigated rice of Maga. Which shows that rice cultivation is a favorable environment for the development of these natural enemies. Collected predators occur in various orders and families of arthropods (insects and spiders). Collected predators are divided into shock predators whose attack the abundant populations of prey (Odonata) and predators of cleaning that can efficiently find their prey and grow even at the expense of low populations (Coccinellidae).

The majority of predators actively pursuing their prey and capture them, in the race (Coccinellidae) or hopping (spiders). Spiders are polyphagous predators attacking a wide range of prey. They catch insects on racing, either by building variable webs depending on the species.

According to CTA (1995), insects predatory (*Araneus* sp, *Tetragnatha* sp. and *Pardosain jucunda*) have an Entomophagous action that regulates the level of populations of insect pests.

The strong appearance of predators during talling and heading is justified by the fact that during this period the insects are also present in abundance. These insects are prey for spiders. Dragonflies (*Lestes* sp. and *Palpopleura* sp.) are very good sailboats that capture their prey in flight and act in regulating populations of insect pests and vectors of the rice yellow mottle. Predators Act in regulating the populations of other species through the intensification of their predatory activities. They are thus as potential biocontrol agents.

During the cycle of rice cultivation there is a growing trend in number of predators. The most abundant species is *Conocephalus maculatus* which is an orthoptera which is both entomophagous and phytophagous which appears to heading with an extensive outbreak in maturity. Meanwhile for *Lestes* sp. is abundant in talling and remains present throughout the whole cycle of the plant, the species *Araneus* sp. as for him disappears at maturity.

4.3. Dynamics of insect pests according to phenological stages of rice

The curves below show the dynamics of insect pests on the different phenological stages of rice according to variety (IR 46 and NERICA 3) and treatments.

4.3. 1. Dynamics of insect pests on the IR 46 variety

The curve below shows the dynamics of insect pests on the different phenological stages of rice on the IR 46 variety

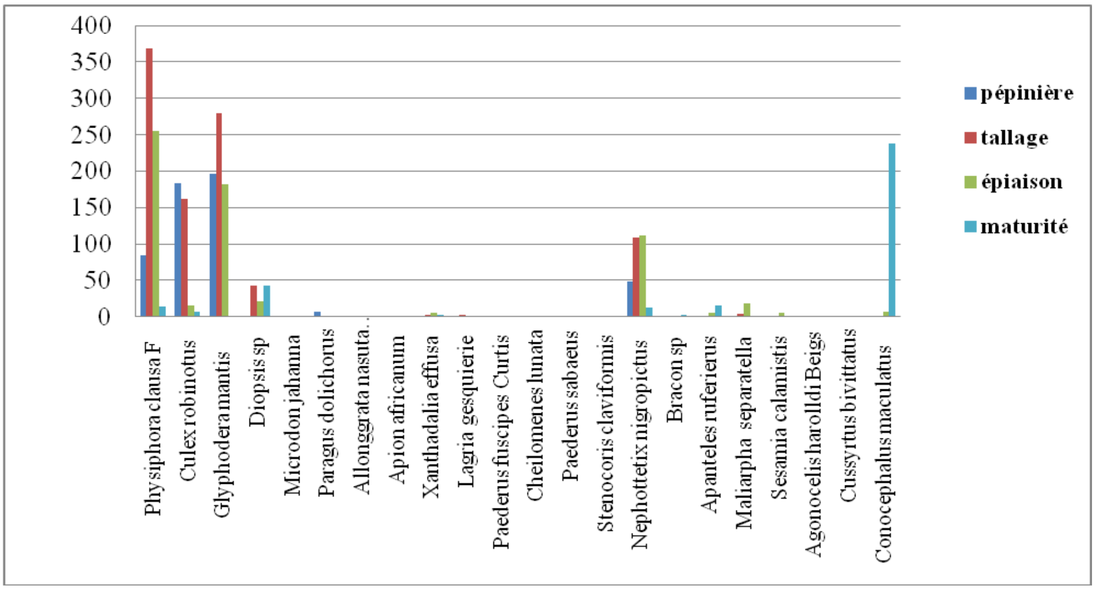


Figure 9: Dynamics of insect pests on the IR 46 variety according to the phenological stages

It is clear from this figure that the *Physiphora clausa* F species is the most abundant, and sets a staff of 369 in talling. The *Glyphodera mantis* species comes in second place and reached its peak at talling with a staff of 279 to talling which fall in heading and disappears at maturity. *Conocephalus maculatus* is the third most abundant species that reaches its peak maturity of grain, it is absent in the nursery and talling. *Culex robinotus* is the fourth most represented species, which reaches its peak in the nursery with a staff 162 species and decreases to an establishment strength of 07 species at maturity. Other pests are present but are poorly represented.

4.4. 2. Dynamics of insect pests on the NERICA 3 variety

The curve below shows the dynamics of insect pests on the different phenological stages of rice on the NERICA 3 variety.

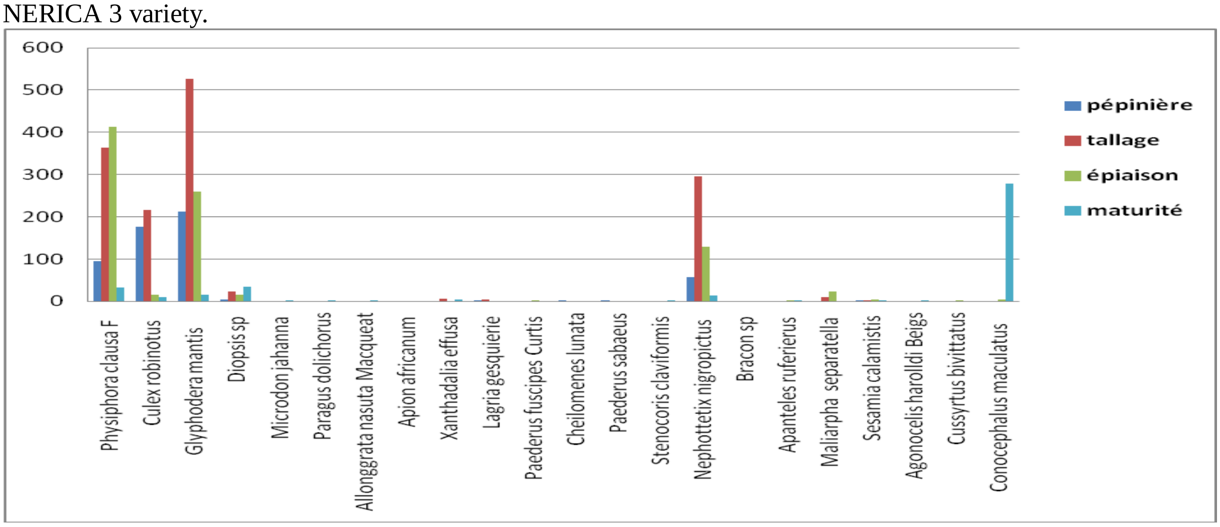


Figure 10: Dynamics of insect pests on the NERICA 3 variety according to the phenological stages

It is from this figure that the *Glyphodera mantis* species is the most abundant, it reached a peak of 526 species in tallring, this number of species declined at maturity to reach an effectiveness of 16 species. *Physiphora clausa* F appears in second with a workforce of 364 talling species; *Nephottetix nigropictus* comes in third and reaches a maximum at tallring with a rate of 296 species which decreases. .

Conocephalus maculatus which is an insect predator and phytophagous comes in fourth place and reaches its maximum at maturity with a strength of 278 species. Species: *Diopsis* sp, *Microdon jahanna*, *Paragus dolichorus*, *Allonggrata nasuta* Macqueat, *Apion africanum*, *Xanthadalia effusa*, *Lagria gesquierie* and *Paederus fuscipes* Curtis, *Cheilomenes lunata*, *Paederus sabaeus*, *Stenocoris claviformis*, *Bracon sp*., *Maliarpha separatella*, *Cussyrtus bivittatus*, *Sesamia calamistis*, *Agonocelis harolldi* Beigs, *Apanteles ruferierus* are presented with of variable strength according to the rice phenological stage.

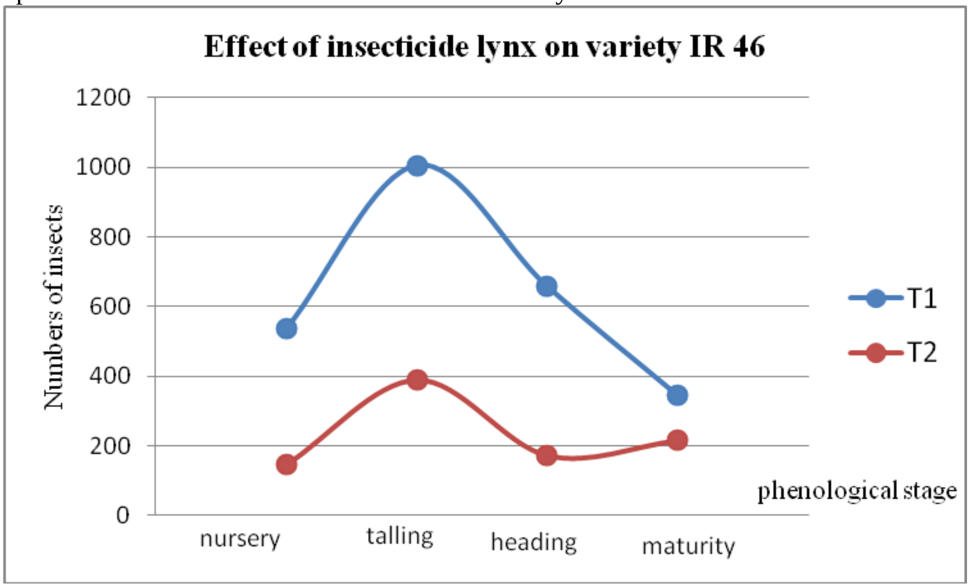
At the end of this work, it is clear that the phenological stages of rice present differences between them, a significant difference (P = 0. 0085), which shows a dynamic of insect pests on the different phenological stages of the rice in the rice-growing ecosystem of Maga.

4.5. Effect of chemical treatment on insects of rice

The curves below shows the evolution of the effect of lynx on the insects, base of the two varieties of rice used in the ecosystem of Maga.

4.5.1. Effect of lynx insecticide on variety IR 46

The curves below show the evolution of the effect of lynx on insects. The result of the analysis of variance showed a significant difference in the effect of insecticide lynx on insects following the various stages of rice with a probability of p = 0.02 to the threshold of 5% on the IR 46 variety.



Legend : T1 : Withness, T2 : chemical treatment base on insecticide lynx

Figure 11 : Effect of insecticide lynx on variety IR 46

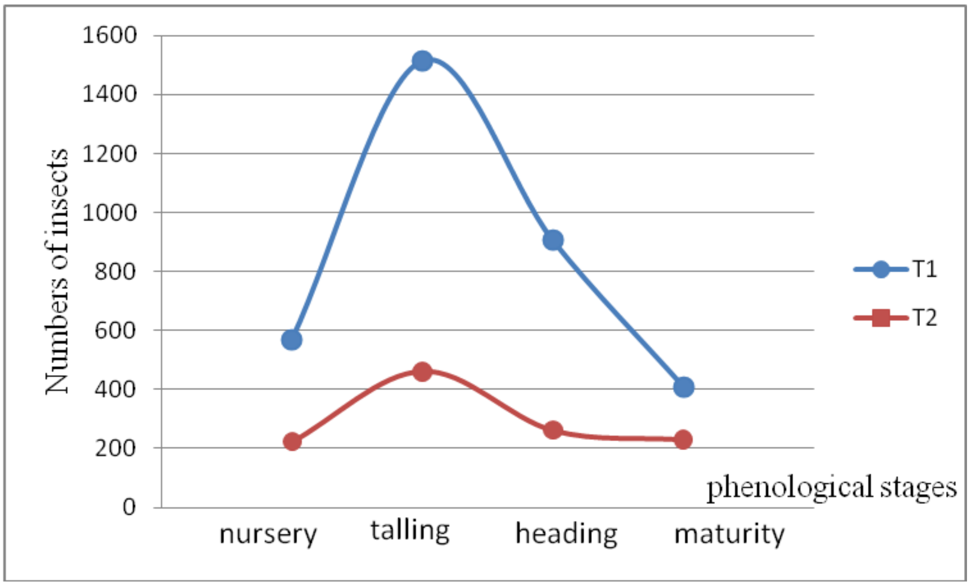
Legend: T1: witness, T2: chemical treatment of insecticide lynx

Figure 11: Effect of the lynx on the IR 46 variety insecticide

The analysis of variance performed shows us that the lynx have a significant effect on insects. There is a significance difference with P = 0.02 following the various stages, so we can say that lynx has a beneficial effect on insect pests of rice. Similarly, an observation based on the inventory of insects shown us strength of 2474 insects collected on witnesses and 906 insects collected on plots treated with lynx on variety IR 46. This observation enable us to say that lynx insecticide reduced insect to 36.62% at the end of the production, that is a rate 5,78% in nursery, 15.44% talling, 6.83% at heading and 8.56% at maturity.

4.5.2. Effect of lynx insecticide on variety NERICA 3

The curves below show the evolution of the effect of lynx on insects. The result of the analysis of variance showed a significant difference in the effect of lynx on insects following the various stages of rice thus with a probability of p = 0.032 to the threshold of 5% on NERICA 3 variety



Legend: T1 : Control, T2 : chemical treatment with lynx
Figure 12: Effects of insecticide lynx on NERICA 3 variety

The analysis of variance performed shows that the lynx has a significant effect on insects. There is a significance difference of P = 0.032 following the various stages, so we can say that lynx has a beneficial effect on insect pests of rice. Similarly, an observation based on the inventory of insects has shown us a strength of 3264 insects collected on witnesses and 1148 insects collected on plots treated with lynx on NERICA 3 variety. This observation enables us to say that the lynx insecticide reduced insect to 35.17% at the end of the production. That is a rate of 6.70% in nursery, 13.75%, talling, 7.78% heading and 6.92% to maturity.

4.6. Effect of varieties on insects of rice

Table 9 presents the analysis of variance for the effect of varieties on the insects of rice in the 5% threshold. Analysis of variance of the varietal effect (IR 46 and NERICA 3) on insects of rice in the 5% threshold.

Table 9: presents the analysis of variance for the effect of varieties on the insects of rice in the 5% threshold

Source	Sum of squares	DDL	Average square	F-Ratio	P-Value
V:	305809,0	1	305809,0	0,16	**0,7266**
T:	3,69793E6	2	3,697936	18,74	0,032
Total (Corr.)	4,09254E6	3			

Legend: V: variety, T: treatment, DDL: degree of freedom

From this analysis, it appears that no significant difference exists between the two varieties on the number of insects; because the value of the critical probability (P-Value) is far less than 0.05. This result explains that the attack of insects does not take account of these two varieties.

The histogram below shows us the evolution of insects according to variety.

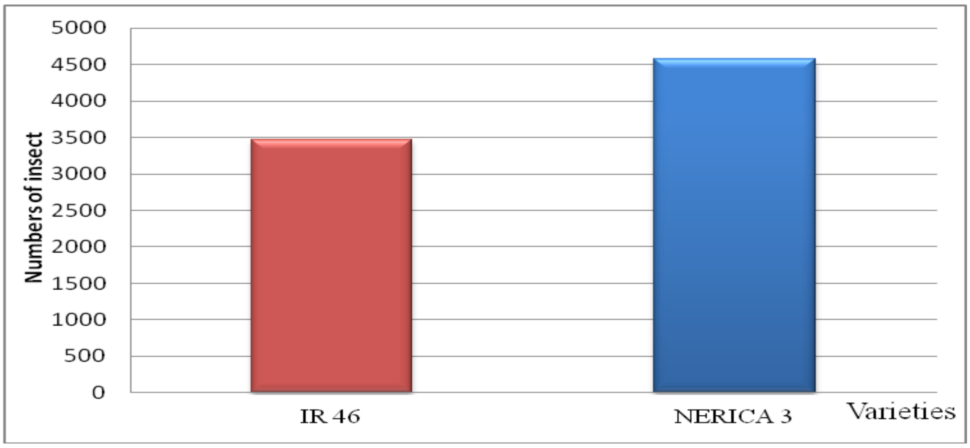


Figure 13: Evolution of insects on variety IR 46 and NERICA 3

The result of the analysis of a threshold of significance of 5% variance shows that there is no significant difference between the two varieties (IR 46 and NERICA 3) of rice for the attack of insects with a probability of p = 0.72. But numerically there is a slight difference on the number of insects collected at the end of the production. On the IR 46 variety there is an effective of 3469 insects with an infestation rate of 43.12% compared to 56.87% on the NERICA 3 variety on 8044 insects collected in total at the end of the production. This rate of infestation of 56.87% makes us conclude that insects like NERICA 3 variety than the IR 46 variety.

5. Estimation of Damage by Insect Pests in the Maga Rice Ecosystem

Losses caused by insect pests are evaluated at talling and harvesting.

5.1. Damage due to borers at harvest time

5.1.1. Components for the calculation of loss at harvest

Table 11 below presents the components for the calculation of loss due to borer insects evaluated on two varieties in the Maga site. The formula used for the calculation of the loss is:

$$P = \frac{200\frac{p_1}{n_1} - (p_1 + p_2)}{200} \times 10\,000\ N$$

Table 10: Components for the calculation of loss due to borer insects evaluated on the IR 46 and NERICA 3 variety in Maga site

Varieties/treatments	Control	Chemical treatment
IR 46	n_1= 107 P_1= 0,122 kg n_2= 93 p_2= 0,1 kg N= 375	n_1= 121 P_1= 0,188 kg n_2= 79 p_2= 0,114 kg N= 322
NERICA 3	n_1= 106 P_1= 0,092 kg n_2= 94 p_2= 0,059 kg N= 558	n_1= 112 P_1= 0,04 kg n_2= 88 p_2= 0,01kg N= 480

-n1 = panicles without attacks from borers in the stem;
-n2 = panicles with attacks of borers in the stem (insects present or not);
-p1 = weight of n1.
-p2 = weight of n2;
-N = number of panicles per square meter.
These data have been collected within 15 days of the harvest.

5.1.2. Damage in kg due to borers at harvest time

Table 11 below shows analysis of variance performed on losses (in kg) depending on the treatments and varieties on the 5% threshold.

Table 11: Analysis of variance performed on losses (in kg) depending on the treatments and varieties (IR 46 and NERICA 3)

Source	sum of squares	DDL	mean square	F-Ratio	P-Value
T:	5694,21	1	5694,21	0,51	**0,5498**
V:	21135,3	2	21135,3	6,08	0,1326
Total (Corr.)	28088,4	3			

Legend: V: variety, T: treatment, DDL: degree of freedom

In this analyses of 5% threshold, it appears that there is no significant difference existing between the losses obtained on treatments (P = 0.54) and varieties (P = 0. 13); thus the critical probability value (P-Value) obtained are far more than 0.05. These results explain that lynx does not have too many effects on drillers because they are in the interior of the stem cells.

Table 13 below, presents the results for the loss in kilogram calculated on two varieties. The summary of the analysis of variance shows that there is no significant difference on the loss expressed in kilogram between two varieties and treatments.

Table 12: Results relating to loss in kilogram calculated on the varieties IR 46 and NERICA 3 base on treatment

Variety IR 46		**Variety NERICA 3**	
Control	Chemical treatment	Control	Chemical treatment
252,58 kg	141,64 kg	362,48 kg	322,50 kg

However, numerically the highest loss is observed on variety NERICA 3 on the control. The smallest number of loss (141, 64 kg) is obtain by variety IR 46 on chemical treatment, we notice that loss on chemical treatments is weak compared to controls. With regard to the two varieties, analysis of variance showed that there is no significant difference (P = 0. 15) between the values obtained on the losses on harvest. Based on a simple observation of the calculated data on losses, one can conclude that loss on NERCA 3 variety is slightly higher than that of IR 46 variety.

5.2. Damage due to insects at talling

5.2.1. Components of calculation of loss at talling

Table 13 below presents calculation components of loss due to insect collected from the two varieties obtained in the field. The formula used for the calculation of the loss is:

$$P_a = \frac{P_1}{n_1} \times 10\,000\ (N - N_t)$$

Table 13: Components for the calculation of loss due to insects at talling on IR 46 and NERICA 3 variety

Varieties/treatments	Control
IR 46	n_1= 93 P_1= 0,11 kg N= 375 N_t = 322
NERICA 3	n_1= 112 P_1= 0,082 kg N= 558 N_t = 480

-Nt: average number of fruiting stems / m2 plots witnesses;
-N: average number of fruiting stems per meter square plots;
-n1 = number of stems without attacks of drillers;
-p1 = grain weight n_1;
-Pa = loss of harvest due to insects acting before bolting;

These data have been collected at the stage of talling and maturity at least 15 days of harvest.

5.2.1. Damage in kg due to insects at talling

Table 14 below, presents the results on loss due to insect expressed in kilograms on the two varieties. Here losses have been calculated only on the control.

Table 14: Relative results of loss due to insects expressed in kilograms on IR 46 and NERICA 3 varieties

Table 14 : résultats relatifs aux pertes due aux insectes exprimé en kilogramme sur la variété IR 46 et NERICA 3

Varieties	Weight in kg
IR 46	626,88
NERICA 3	571,07

The result of calculation of loss due to insects amounted to 571,07 kg of rice for NERICA 3 variety and 626,88 kg of rice for IR 46 variety. A comparison of these losses shows that there is no great difference between these two losses on the varieties. But basing on the results obtained, we found that insect pests have a huge impact on yield thus in our studies, we assessed 1197,95 kg or 1.19 tones.

5.3. Evaluation of yields

5.3.1. Components of yield

Table 15 below presents the components of yield obtained on two varieties of rice. The formula that was used for the calculation of these returns is as follows:

RYC = NP/ha x NT/P x Npa/T x NG/Pa x PG
RYC = Production/ha
NP/ha or NP/m2 (10,000 m2) = number of plants per hectare
NT/P = number of tillers/feet
Postal code/T = number of panicle/taller
NG/Pa = number of grain/panicle
PG = weight of a grain.

Table 15 **: Composantes de calcul de rendement obtenu sur la variété IR 46 et NERICA 3 en fonction des traitements**

Components	**Yields in kg**			
	IR1	**IR2**	**N1**	**N2**
Numbers of plants in m^2 (NP/ m^2)	896	896	896	896
Numbers of talle/foots (NT/F)	9	9	9	9
Numbers of panicle/talle (NPa/T)	1	1	1	1
Numbers of grain/panicles (NG/Pa)	215	288	211	265
Weight of a grain (WG)	0,001	0,001	0,001	0,001

Legend: IR1: IR 46 control, IR2 variety IR 46 treated with lynx, N1: variety NERICA 3 control, N2: NERICA 3variety treated with lynx.

These components of yield have been assessed at least 15 days from harvest to the stage of maturity.

5.3.2. Yield in kg on two varieties of rice (IR 46 and NERICA 3)

Table 16 shows the analysis of variance performed on yields depending on the treatments and varieties. These tests were performed on the threshold of 5%.

Table 16: Analysis of variance performed on yields depending on the treatments and varieties (IR 46 and NERICA 3)

Source	sum of squares	DDL	mean square	F-Ratio	P-Value
Treatment	262211,0	1	262211,0	29,60	**0,0322**
Variety	17719,9	2	8859,960,09	**0,7942**	
Total (Corr.)	279930,0	3			

Legend : V : variety, T : treatment, DDL : degree of freedom

It is clear from this analysis that at the threshold of 5% probability, there is a significant difference between the yields on the treatment (P=0,03), but not on varieties; because the critical probability value (P-Value) obtained (P = 0.79) is far more than 0.05. These results are explained by the fact that the varieties are different. This difference could be at the origin of different yields, which means that the insecticide lynx has an effect on yield.

Table 17: Yields evaluated on a hectare on two varieties of rice (IR 46 and NERICA 3) evaluated treatments.

Yield evaluated in kg	Varieties and treatment			
	IR1	**IR2**	**N1**	**N2**
Yield obtained on a hectar in kilogram	1733,76	2322,43	1701,50	2136,96
Yield obtained on experimental scale	43,69	58,52	42,87	53,85

Legend: IR1: IR 46 control, IR2 variety IR 46treated with lynx, N1: variety NERICA 3 control, N2: NERICA 3variety treated with lynx.

The analysis of the variances of the yield on two varieties has shown that there are no significant differences between the two varieties but with a significant difference between treatments (control and chemical treatment). The IR 46 Variety gave a yield of 2.02 t/ha and NERICA 3 1.91 t/ha. The control on both varieties gave a yield of 1.71 t/ha and the chemical treatment 2.22 t/ha. These show a difference of 0.10 t/ha between varieties and a gap of 1.08 t/ha among treatments.

6. Discussion

6.1. Diversity and dynamics of insect pests and auxiliary of rice in the rice-growing ecosystem of maga

The results obtained on the diversity and dynamics of insect pests and auxiliary of rice, has shown us that insect pests and auxiliary collected on plots of rice are both present at the ground level as on the parts of the plant of rice. The six collected orders (Diptera, Lepidoptera, Coleoptera, Hemiptera, Orthoptera, Hymenoptera, Odonata and Araneae) contain individuals likely to be pests or auxiliary of rice culture.

6.2. Diptera

It appears from this study that seven species of Diptera in five families (Otitidae, Culicidae, Micropezidae, Syrphidae and Diopsidae) have been collected from irrigated rice of Maga. These Diptera are phytophagous insects, likely to cause damage on rice. Their larvae feed on the leaves where they cause windings. The abundance of Diptera observed at talling and is justified by the fact that during this phase the leaves of young tillers are well-developed, contain nutrients that provide food for these insects. In this same idea that BRENIERE said in 1969 that talling is the longest phase in the cycle of rice where we see many insects. For Paul ONDO OVONO et al. 2014, Diptera are reported on rice from the seedling stage to the stage of maturation. It is especially in the talling stages and initiation the of panicle that their presence is strongly reported.

Their abundance may also be explained by the existence of cultures of different cycle which promote their multiplication, the presence of weeds that serve as a refuge, secondary host, niche and Habitat for insects. The absence of rotation of crops, the rains followed by dryness, relative humidity (can favour or destroy the larvae of insects), water for irrigation (by larvae transportation). Bakker in 1974, Gristetal, in 1969 identified among the species of the order Diptera *Diopsis thoracica* (Diopsidae) are vectors, stem drillers and recognized as an insect vector of the rice yellow mottle virus.

During the maturity stage, the leaves and stems wither and Diptera can no longer feed on the plant, this justifies the decline in the population of Diptera during this stage. This decline in the population of Diptera can still be explained by the increase of predators (*Conocephalus maculatus*) at the stage of maturation. During this period the Diptera assemble themselves in swarms or near permanent ponds or wet lowlands. Their dispersion occur as soon as we observes the first rains and it is at this time that these insects attacks the rice in order to feed. This justifies their abundance presence at the nursery stage in all the three sites. In this order the species most represented is *Physiphora clausa* F with a high talling number.

6.3. Coleoptera

In the order of Coleoptera five species in four families have been collected on rice. Beetles are insects that can be seen in several aspects. We have harmful species, essentially phytophagous species in foodstuffs, some of which are major pests. Others are instead predatory (Coccinelidae, Staphylinidae...) and sometimes participate in the elimination of pests. Mathur et al. (1971), cited by Heinrichs E. A., Balaji. T, (2004), in the order of Coleoptera we have four families which are present in Africa and are predators, they include Anthicidae, Carabidae, Coccinellidae, and Staphylinidae. Sadou and *al*. (2008), still in the order of Coleoptera four species of insects pests are potential vectors of yellow variegation of rice which were collected: *Dicladispa armigera, Leptispa pygmea, Oulema oryza* and *Trichispa sericea.*

Among the collected beetles we identified (*Apion africanum, Lagria gesquierie*) pests and predators (*Paederus fuscipes Curtis*, *Paederus sabaeus, Cheilomenes lunata* and *Xanthadalia effusa*). Pests attacked the vegetative organs (leaves, stems and panicles) of the plant, larvae form a gallery (tunnel) in the thickness of the leaves by eating the tissues and adults gnaw leaves. But the most serious damage is caused by transmission of the virus by the beetles in the family of chrysomelidae and Coccinellidae. At the maturation stage the beetle population size decreases. The maturity stage is marked by the senescence of leaves and stems so pests beetles can no longer feed on the vegetative parts of the plant thus this justifies the decline in population during this stage.

6.4. Hemiptera

In the Hemiptera order we had identified three species belonging to three different families. Hemiptera are important pests in the irrigated rice ecosystem. The adults live in the upper parts of plants and can fly long distances, up to several kilometers. The nymphs and adults suck the fluids from the leaves, causing some stunting. The most serious damage is caused by the transmission of the yellow variegation virus of rice by these pests.

Among the collected Hemiptera, *Nephotettix nigropictus* which is a stinker driller is the most abundant species. According to Gristetal, (1969), Hemiptera *Nephotettix sp* and *Nilaparvata lugens* Stal were indeed recognized as vectors of serious diseases: Tungro, the Yellow dwarf and the Grassy Stunt Virus in which it extension appears to extend with the development of highly productive varieties with high talling. It from this same idea that the SPID project in Mali in 2011, showed that among the harmful insects or insect pests which can severely damage or destroy a rice crop or harvest *Nephotettix nigropictus*, a stinker driller causes leaves yellowing, stems and creates black spots on the leaves.

The abundance of Hemiptera observed at nursery and talling stages is justified by the fact that during these two stages, the plant possesses well-developed vegetative organs thus Hemiptera are essentially good at sucking leaves. During the stages of heading and maturity, the quality and quantity of fluid contained in the leaves and other parts of the plant declines this justifies the decrease of the population during these stages because they do not have feed. The maturity stage is marked by a change of color, defoliation and advanced senescence of leaves which are less numerous and of poor quality.

6.5 Lepidoptera

In the order of Lepidoptera, we have identified two species *Maliarpha separatella* (Pyralidae) and *Sesamia calamistis* (Noctuidae) which are the stinker drillers and stem borers at the lavae stages. The specie *Maliarpha separatella* is present in all the phonological stages of rice, its at the heading stage that its attend its pick and then start falling in the maturity stage. For Paul ONDO OVONO and *al.*, 2014, lepidoptera are being alerted on rice at the talling stage toward maturation but are more abundant in talling stage and heading-flowering. The presence of these adults insects indicates the beginning of hatching. For Brenière in 1962, *Maliarpha separatella* is specific to *Oryza* gender. It found then only on cultivated rice and wild rice. The female does not hatch on young plants but only on adult leaves during talling (early as 15 days after transplanting in irrigated rice)

The egg deposition becomes scares from heading. The development of the margot is thus more rapid than when its intervene in plants of great height Wopereis et *al.*, 2008, found the Lepidoptera order. The most important of the lepidopteras which causes damage are: *Chilo spp. Maliarpha separatella, Sesamia calamistis, Nymphula depunctalis, Eldana saccharina, Scirpophaga spp.* But in our studies we note *Maliarpha separatella* (Pyralidae) *and Sesamia calamistis* (Noctuidae) which are redoutables stems borers.

The attacks of *Maliarpha separatella* causes the formation of white panicles thus they alters the base of the stems where lavae are found and the growth during heading of rice. Whereas when the panicles are form normally, the attacks of the lavae does not affect maturity (Appert, 1970 ; Pollet, 1979).

Damages on leaves are mostly caused by the lavae of *Maliarpha separatella* and *Sesamia calamistis* which are predominant lepidoptera, we also have the case of *Diopsis sp* (Diptera) which is a stem borer and same time vector of yellow variegation of rice. The gender *Chilo* Whom we did not encounter constitute the most economic scavenger (Saliou DJIBA, 1986). According to VERCAMBRE (1979), The combine effect of these damages causes a lost in yield which was estimated at 25% of harvest in intensive culture.

6.6. Orthoptera

The orthoptera order is less represented in our studies. Two families of orthoptera was collected Avididae and Tettigoniidae with species of *Conocephalus maculatus and Cussyrtus bivittatus* which are two scanvegers appearing in heading stage. We note the disparition of *Cussyrthus bivitttatus* and an abondance of *Conocephalus maculatus* at maturity. For (Pande and *al.*, 1997) cité par Paul ONDO OVONO *et al*., 2014, *Conocephalus maculatus, Cussyrtus bivittatus…)* and Gryllidae make up the known scavenders of rice.

Studies has shown that the family of Tettigoniidae (with the species *Conocephalus maculatus*) are found abundantly at maturity of the grains. They were caught with sweep net on rice. They are numerous in NERICA 3 variety with an effective of 278 at maturity. For Paul ONDO OVONO *et al*., 2014, orthopteras are the most abundant insects at the initial stages of panicles and grain maturity and a null at nursery and heading stages. This explains their absence at nursery and talling.

The abundance of *Conocephalus maculatus* can also be justified by the fact rice maturation coincide with the period of population of this species and that this period coincide with rainy season which creat a favourable condition for population. *Conecephalus maculatus* is the most represented specie at maturity. *Conecephalus maculates* (Orthoptera) is a phytophagous leaves chewer of rice and panicles and predators of larvae of margot, nymphs (Shepard and *al.,*1991) and the egg of Noctuidae (van den Berg et *al* 1992) cited by Heinrichs E. A., Barrion A. T, (2004). Thus they feed on larvae of margot, nymphs and leaves of rice.

6.6. Hyménoptera

The order hymenoptera is the less represented order with *bracon sp* and *Apanteles rufierus* which are all two braconidae. These two insects are parasites which hatches their lavae inside a host (Williams et *al.*, 2002) cited by Pierre Silvie (2012). The presence of these insect can be due to the engolvement of their host present in the parcels.

6.7. Odonate and Aranide (predators)

In odonate order, were able to identify two species *Lestes spp* and *Palpopleura sp* belonging to two different families. These two insect are predators which attacks the abundant population of preys and captures their preys by hunting in flight. The SPID project in Mali, (2011), showed that the males and females which attack the insect in flight that is the saturess, diverse larvae or aquatic eggs which make the plants to grow again.

The order of aranides is represented by two species *Araneus sp and Tetragnatha juculator,* which are all two of predators. Chasse their preys and capture them by hopping. Wopereis et *al.*,(2008) found that among the predators, the most important is the spider.

In effect, a spider can feed on 30 white cicadelles daily. Spiders are polyphagous predators attacking a large range of preys. She captures insects by chasing them or by construction of web according to species. The particularity about spiders is that they do not feed on rice, feeds only on insects contrary to insect predators that's feeds on rice and insects.

According to CTA (1995), insect predators (*Araneus sp*, *Tetragnatha sp*. And *Pardosa injucunda*) has an entomophagous action which enables the regulation at the level of the population of insect scavengers. It's from these same sense that Ly ideas in 1978 cited by Heinrichs E. A., Barrion A. T, 2004, found that *Araneus sp and Tetragnatha juculator* are the abundant species in irrigated rice culture.

The strong apparition of predator during the periods of talling and heading is justified by the fact that during these periods insect scavengers are present and are in abundance. These insects are preys to spiders. Arthropods make up the most interesting and important entomophagous predators notabling the polyphagous species of insects (Sunderland *et al.*, 1983). Predators acting in the regulation of the population of other species across the intensification of their predatory activities. They presents themselves as agent of biological fight.

7. Damages cause by insect scavengers in rice ecosystem of Maga

The results obtain showed that 49,98% of loss are caused by insect scavengers. This results was also obtained by Arhent et *al.* (1983) in which they found that of the41,1% of total loss on rice, 27,5% was due to insects, for him the damages cause on rice was done by insect scavengers which are at once deparasitors and vectors of diseases. This results obtained is not significatively different from those whom we obtain from rice culture in Maga. Also our work was base at the perimeters of SEMRY of Maga meanwhile Arhent did work but on regional scale. Also, on the perimeters of Maga rice culture, we obtained a loss of 26,30 % at talling and a loss of 23,68 % during harvest on two varieties.

This results confirms of fight against scavengers. In the same order of idea, in Cameroon in 1954, Descamps (1956) rapported 75 % of damage caused by insects' scavengers localized at the valley of Logone (Far north). Traoré et al., (2001), in Cameroon in all rice culture situations, insect scavengers causes 25 to 100 % of loss every year. This results also shows a loss at talling cause by stem borers which are mostly lepidopteras and dipteras and have caused up to 26,30 % of loss on yield. In this order of idea, VERCAMBRE, (1979) cited by Saliou DJIBA, (1986) declaire that the combine effect of damages of *Maliarpha separatella, Sesamia calamistis*, *Chilo* sp (Lepidoptera) and *Diopsis sp* (Diptera) which are stem borers causes a loss in yield estimated at 25% of harvest in intensive culture. Our results show that there is a significant difference on loss caused by insects on parcels without any insecticide treatment (control) and on parcels with chemical treatment. What enables us to say that these insecticides treatments have an effect on insects thus where the necessity to bring savior treatment on yield. Also, these results on stem borers is in the same order with the results obtained in similar ecological zones and other African regions were loss caused by borers are estimated between 2 and 38 % (Dakouo *et al.*, 1992 ; Heinrichs, 1998) citd by Abou Togola 2010.

8. Yield evaluated in the ecosystem of Maga

The average yield obtained from the trial was 2,02 t/ha for IR 46 variety and 1,91 t/ha for NERICA 3 variety. The control of the two varieties gave 1,71 t/ha and chemical treatment 2,22 t/ha respectively. These gave a difference of 0,10 t/ha between the varieties and 1,08 t/ha between the treatments. These differences at level of varieties are due to the fact that NERICA 3 is a variety which is much more adapted to rainy season. The significance difference on yield on treatment shows the importance of lynx on yield, similar results was obtained by Awinakai, (2001) which he showed in Cameroon that many local varieties of rice are cultivated: IR 8, IR 46, IR28 et SECA 8.

Beside these local varieties, we also have improve varieties of type NERICA very productive, yields between 5-7 t/ha and vegetative cycle of 85 to 100 days. We equally have other varieties like FKR56, FKR 58, FKR 60, FKR 62, TOX 3100 and TOX 4004. According to Awinakai, (2001) the most productive variety was IR 46, it responded to the criteria of peasant farmers (yield between 1 et 3 t/ha, vegetative cycle of 130 days, resistant to diseases,) and behaves well during irrigation. Similar results was obtained by Peng et *al.*, (2000) in which he found the yields in tropical irrigated rice culture with the variety indica of type IR46 and was in the order of 1 to 3 tones per hectar. In the same order of idea, the association for the development of rice in West Africa (ADRAO) characterized NERICA 3 to 8 tones in rainy season and variety IR 46 1 to 3 tones per hectare. The results obtained by different authors confirm the results which we obtained on the perimeter of rice culture of Maga with the two varieties used. The minister of agriculture Malien (2009) showed that in rice culture in Mali 4 varieties of seeds are used and they obtained an average yield of 1 to 8 tons per hectar. This is another result that is not showing a great divergent with that which we obtain from our studies.

Conclusion

The studies on the effect of insects scavengers on the yield of rice enable us to explore on insect scavengers of rice in the irrigated rice ecosystem of the Far north Region. These exploration enabled to navigates across many insects orders namely: Hemipteras, Dipteras, Coleopteras, Lepidopteras, Hymenopteras, Odonates, Orthopteras, and also the order of Aranides found in this ecosystem. Tweenty-three species of insects belonging to nineteen family and repartition in seven orders were collected in rice ecosystem of Maga.

The captured insects were numerous at talling stage with a difference of effectiveness of 1373 insects compared to other stages. Among the species collected in rice culture site, *Physiphora clausa F* of the family of Dipteras were the most abundant. The insects which caused alot of damage are *Maliarpha separatella, Sesamia calamistis* belonging to the order of Lepidopteras, and *Diopsis sp* which is a Diptera. *Maliarpha separatella and Sesamia calamistis* are chewers at larvae stage; their larvae and those of *Diopsis sp* are stem borers which has cause damages estimated *of* 23,68 % during harvest what causes a drop in yield. The most represented order is that of Dipteras with *Physiphora clausa F, Culex robinotus, Glyphodera mantis, Diopsis sp, Microdon jahanna, Paragus dolichorus and Allonggrata nasuta* Macqueat and least represented order is Hymenopteras with *Bracon sp, Apanteles ruferierus.* We notice that the NERICA 3 variety is much love or attacked by insects compared to IR 46.

Also, away from insect scavenger, some natural enemy like predators and parasitoids were registered. The predators collected were much at the stage of maturity. But we have to note that spiders are the most important predator thus natural enemies that like to fight against insect scavengers. Among the natural enemies captured the species *Tetragnatha juculator* (Araneae : Tetragnatidae), *Lestes spp* (Odonate : Lestidae) are present in all the phenological stages. The presence of these predators are of great importance and help much in natural regulation of the population of insect scavengers and diseases (vectors).

The loss caused by insect scavengers on the culture of rice in Maga was of 49,98% on the two varieties. This result confirms the importance of phytosanitory fight with an objective to increase production. We have to also note that there was also loss cause by birds, diseases, on rice culture. The loss caused by insect scavengers of rice were evaluated at 26,30 % in talling and 23,68 % of the harvest on two varieties. We notice that these losses were not same on parcels without insecticides and parcel treated with lynx. This difference in loss enables us to say that insecticide lynx have a protective effect on the culture of rice and reduce the numbers of insect on all its phenological stages, consequently reduces the damage of insect on rice. The yields evaluated gives us a difference between the treatment, We note a difference of yield of 1,08 t/ha between parcels without insecticide (control) and parcels treated with insecticide lynx chemical treatment. This makes us to say that insecticide lynx have an effect on yield by its capacity to destroy insect scavengers.

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