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Inventory of insects damaging the plants of rice and vectors of diseases in the irrigated area of Bugorhe in Kabare district in the South Kivu Province in East of Democratic Republic of Congo

CHIHIRE Barhahakana[1*], RUBABURA Kituta Jean Augustin[1], BAKULIKIRA R[2], RUTAKAYINGABO M[3], BISIMWA Basengere Espoir[4], and WALAGULULU Masamba Jean[4]

[1]Department of Biology, Laboratory of Agriculture Entomology,
Centre de Recherche en Sciences Naturelles (CRSN) Lwiro, DS./Bukavu,
Bukavu, Sud Kivu, République Démocratique du Congo

[*]Faculty of Agriculture and Environment, Mastery Program (U.E.A- BUKAVU),
Evangelical University in Africa,
Bukavu, Sud Kivu, République Démocratique du Congo

[2]Vegetable Program, National Institute for the studies and Agriculture Researches, INERA-Mulungu,
Bukavu, Sud Kivu, République Démocratique du Congo

[3]Department, Higher Institute of Rural Development to Bukavu, ISDR-BUKAVU,
Bukavu, Sud Kivu, République Démocratique du Congo

[4]Faculty of Agriculture, Catholic University of Bukavu (U.C.B-BUKAVU), B.P:285/BUKAVU
Bukavu, Sud Kivu, République Démocratique du Congo

ABSTRACT: The study of the insects damaging the crops and vectors of diseases of rice culture in the marshy high land of Bugorhe area in Kabare district in South Kivu province in the East of Democratic Republic of Congo was conducted from August 2012 to December 2013 on the different phases of development of the culture. Samples were collected by means of a harvest spider and a suction device after each three days for a period of three cultural seasons. Information relating to the incidence of insects, frequency and the density of destruction of plants were recorded. The methods of observation and triangulation were adopted at random to select the lots of rice and collect insects. To identify insects, all keys were adopted. Other keys as for comparing species between them, were resorted to determine the number of insects studied, we resorted to the International Rice Research Institute Key. As result we have come up to notice: Insects damaging plants vary in number and quality of the different stages of the growth of rice culture.36 Species of insects have been recorded distributed into 16 families mainly Thripidae, pentatomydae, Coeidae, Cecidomyidae, Diopsidae, Pyralidae, Noctuidae, Acridoidae, Alididae, Delphacidae, Cynipidae, Coccinellidae, Chrysamelidae, Meloidae, Cynipidae, Scarabeidae and 7orders suck as Lepidoptera, Coleoptera, Diptera, Hemiptera, Orthoptera, Thysanoptera, and Heteroptera. All the varieties of rice were attacked by the diseases of *Bacteriosis, Pyriculariosis* and the *Rice Yellow Monttle Virus* (RYMV) at the different stages of development of the plant. Species suck Nephottetis spp, are reported to be responsible of the *Rice Yellow Mottle Virus* (RYMV) and the bacteria as *Pseudomonas fuscovaginae* and the *fugus sarocladium oryzae* causes different forms of *bacteriosis* observed in the rice culture in Bugorhe area.

KEYWORDS: Incidence, Damage, Phases of development, Insects vector.

Corresponding Author: CHIHIRE Barhahakana

1 INTRODUCTION

Rice as a cereal is the staple diet of almost half of the world population [29]. The culture of rice is practiced on over 154 million of hectares due to its easy adaptability to the ecological conditions. It is the culture of overpopulated zones to feed the population.

Bugorhe area is on overpopulated locality in the district of Kabare with 130 to 150 in habitants per Kilometers square . Attempts have been undertaken to introduce the culture of rice in this wet marshy high land since 1990. But these attempts have failed to reach the expected harvest because of damage, gnawing insects and insect's vectors of diverse diseases.

Some studies have been conducted to determine the rodents laying waste the rice plants[11], but few information's are available to what relates to insects gnawing the stalks and vectors of some diseases attacking this culture in this area. Or according to the observations affected in the different rice field in Bugorhe, it has been noticed that plants are destroyed by gnawing insects and diseases transmitted by these insects, therefore rendering the production insignificant.

In this study, we have proposed ourselves to make the inventory of the main insects laying waste the plants of rice and the different diseases transmitted by those insects to the plants in order to arrest the strategies to control them and maximize the production of rice in Bugorhe.

2 METHODOLOGICAL APPROACHES

2.1 GEOGRAPHICAL AND CLIMATE SITUATIONS OF THE ZONE OF STUDY.

The study was conducted in the marshes of the sub-district of Bugorhe in the south Kivu province in the east of the Democratic Republic of Congo from August 10th, 2012to December 10th, 2013. These marshes are located between the longitude 28° 48' 50,7" East and latitude 2° 14' 25.5" South at the altitude of 1675meters. The annual temperature average out at 70%. The rain fall reaches out 1700mmper year. The vegetation is dominated by Cyperacea family among which the species of *Cyperus latifolius* and other species such as *Triumfetta Cordifolia* around the dry land and *Comelina diffuxa.*

Table 1. Climatic data in the area during the study period.

Months and Year	Temperatures					Water fall	Number of days
	TM°C	TMn°C	Tma°C	Tm°C	Tma°C	(mm)	
August 2012	**24.9**	**13.2**	**27.0**	**19.1**	**11.0**	**96.0**	**5**
September 2012	**26.5**	**13.7**	**28.6**	**20.1**	**11.0**	**178.2**	**15**
October 2012	**26.4**	**13.9**	**27.6**	**20.2**	**12.2**	**250.0**	**24**
November 2012	**26.0**	**14.3**	**27.2**	**20.2**	**12.2**	**125.8**	**11**
December 2012	**26.0**	**13.9**	**29.0**	**20.0**	**11.8**	**228.8**	**19**
January 2013	**25.8**	**14.8**	**20.3**	**13.0**	**28.0**	**130.2**	**17**
February 2013	**27.1**	**13.9**	**20.5**	**12.0**	**29.0**	**88.1**	**10**
March 2013	**25.6**	**14.2**	**19.9**	**12.5**	**29.0**	**223.8**	**20**
April 2013	**25.8**	**14.6**	**20.2**	**12.5**	**27.5**	**136.4**	**11**
May 2013	**25.0**	**14.2**	**19.6**	**12.0**	**26.5**	**127.4**	**9**
Juin 2013	**25.5**	**12.3**	**18.9**	**11.5**	**27.5**	**2.5**	**1**
July 2013	**26.4**	**13.2**	**19.8**	**11.5**	**28.0**	**0.4**	**1**
August 2013	**25.8**	**14.4**	**20.1**	**10.5**	**28.0**	**65.8**	**5**
September2013	**25.3**	**14.6**	**20.0**	**12.0**	**28.0**	**185.8**	**16**
October 2013	**25.3**	**14.3**	**19.8**	**12.0**	**27.0**	**109.5**	**12**
November2013	**24.7**	**15.3**	**20.0**	**13.0**	**27.2**	**233.1**	**20**

Source : *Department of Geophysics, Station of Climatology, Centre of Research in Naturel Sciences of Lwiro(C.R.S.N).*
Legend: TM: Maximum Temperature.
TMn: Average temperature.
Tma: absolute maximum temperature per month.
Tm: minimum temperature.
Tma: absolute minimum temperature per month.

Out of this table, we notice that Bugorhe area fits for the culture of rice from the quantity of rainfall per year averaging out at 1000to 1500mm.

2.2 MATERIALS

In our study, we selected 5 varieties of watered rice mainly Vo46, Br14, Vo96, and Fc56, R12. We used as materials a harvest spider, suctit device, varieties of rice, alcohol, tubes, papers, pencils, scissors and binocular microscope.

Table 2. Characteristics of the varieties of watered rice.

Type of varieties	Average height of the plant	Number of tillers	Cultural cycles	Adaptation to environment	Attacks due to birds.
V046	100	11-15	5,5months	++++	Very attacked
Br14	90	15-20	4,5months	++	Very attacked
Vo96	85-100	13-20	4,5months	++	Less attacked
FacAgro56	73-95	10-15	4,5months	++	No attacks
R12	90-100	15-22	5.5months	++	No attacks

Source: Division of Agriculture. Centre of Research in Natural Sciences of Lwiro.
Legend: ++++: Very adapted and ++ : adapted .

The variety Vo46 scams to be very adapted to environment but the most attacked by birds. This reduces the crops gain. At least all the varieties are adapted to the environment of Bugorhe.

2.3 METHODS

On a piece of land of 1500square meters, the observations were conducted in the irrigated region of Bugorhe. 500 square meters were selected at random to constitute an experimental piece of land for a period of three cultural seasons.

The different stages of development of the plants were carefully observed during the cultural cycle. Insects were collected every ten days at random. Each lot of 500square meters was subdivided to quadrant of 2mx2m. Each quadrant contained at least 100plants of irrigated rice. The team effected the observations 4times per week (Monday, Tuesday, Thursday, and Friday) early morning at 5hours 30 to state the symptoms of diseases. The observations were directed on the inventory of gnawing insects, the stalls of the plants destroyed, the number of the dead plants, the tillers diseased or attacked by gnawers. This permitted to determine the incidence of attacks, insects and … diseases (bacteria rotting of sheath, round the stem, Pyriculariosis and the Rice Yellow Mottle Virus, and the percentage of damage according to the following parmeters.

F = *n/N* with:

F= Frequency of rate,

n= Number of individuals on the inferior systematic level,

N= Number of individuals on the superior systematic level to n.

Ii *=F/NPx100*

Ii= Incidence of insects, NP= Number of plants per varieties.

I*a =NPD/NTPx100 with*

Ia= Incidence of attacks, NPD= Number of damaged plants, NTP = Total number of plants.

Incidence of diseases according to TILQUIN (1993)

IBac =NTB x100 /*Tu*

IPy =NTPy x100 /*Tu*

Tu =NTS +NTBac +NTPy +NTPa

With

NTS= Number of tillers no diseased,

IBac= Incidence of *Bacteriosis,*

IPy= Incidence of *Pyriculariosis*.

NTPy= Number of tillers attacked by *pyriculariosis*.

NTBac= Number of tillers attacked by *Bactériosis*

NTPa = Number of tillers tillers attacked by the *Rice Yellow Mottle Virus*(RYMV)

Tu= Useful tillers

*PD = NPA/ NTP ´*100

With

PD= Percentage of damage, NPA= Number of attacks Plants

The method Homme-temps was used to collect the insects by means of mowing plants by a quick lateral movement of moving to and fro on line on a piece of land selected at random. Thanks to this technique, we came up to calculate the results, which are presented [18]. It is difficult to have a standard method because mowing varies according to person to according to the density and the nature of vegetative. The insects are preserved in a tube containing alcohol a 70percent of concentrated, to identify the insects, [24, is used However to determine the families of the insects, the Key of recognition of families of [13], was utilized and to compare different species between them, [5], [7], [6], [16] and [30] keys were of great importance.

The determination of the number of insects is dealt with after the International Rice Research Institute method (IIRI? 1979). This method consists in determining the number of insects in a lot of land during the cycle of the development of the rice plant. The species of insects are counted manually.

3 RESULTS AND DISCUSSIONS

The collected insects vary according to the phases of development of the plant, whereas the quality and quality according to the variety of rice, the material used and the bio-chronology of the species of the insects. According to the phonological phases of the rice, the species of insects vary in abundance and in quality and also that abundance of these species at the different stages varies according to the method of collection.

Table 3. Orders, Families and numbers of species of insects collected on the rice plant at the different phenological phases.

			Number of insects captured at different phases			
Order	Famillies	Species	Sprout	Vege	Gene	Matu
Lepidoptera(579)	**Pyralidae(447)**	Nemphula depuctalis, Guen	0	0	17	50
		Chilo zacconius, ,	24	0	11	17
		Chilo partellus Swinhoe,	0	33	20	8
		Chilo suppressalis Walk.	0	7	13	20
		Malliarpha separatella, ,	0	13	4	45
		Marasmia patnalis Brad,	6	0	53	0
		Schoenobius bipunctifer W	7	40	7	15
	Noctuidae(132)	Nagara aenescens Moore	0	0	13	53
		Sesamia calamistis .	15	42	9	0
Hemiptera(291)	**Alididae(48)**	Leptocorisa varicornis,	0	0	23	25
	Delphacidae(118)	Sogatella frurrcifera,	19	34	0	0
		Nilaparvata lugens	31	9	20	5
	Cicadellidae(125)	Nephottetis nigropictus,	17	33	5	0
		Nephotettix bipunctatus F	28	0	0	0
		Nephotettis malayanus	0	0	42	0
Coleoptera(384)	**Scarabéidae(98)**	Heteronychus oryzae,	14	43	10	4
		Schizonycha africana	0	23	4	0
	Chrysomélidae(197)	**A**sbecesta cyanipennis,	0	15	0	12
		Asbecesta senegalensis,	0	3	11	0
		Lema oryzae Kuw ,	0	24	8	20
		Thrips oryzae Will,	12	4	17	11
		Spodoptera mauritia .	0	35	2	7
		Cirphis unipuncta ,	1	0	27	0
	Méloidae(24)	Mylabris holosericea	0	15	0	9
	Cynipidae(65)	Biorhiza spp	0	0	12	14
		Epilachna spp	0	12	24	3
	Coccinellidae(115)	Chnootriba neglecta	0	34	17	14
		Epilachna Spp	2	11	28	9
Orthoptera (94)	**Acridoidae(94)**	Locusta migratoria ,	0	41	32	0
		Nomadacris septemfasciata	0	7	11	3
Diptera (237)	**Diopsidae(179)**	Diopsis thoracica, West Wood	5	41	38	15
		Diopsis apicalis	3	12	28	13
		Agromyza oryzae	0	3	15	6
	Cécidomyidae(58)	Orseolia oryzivora Wood-Mason	0	34	21	3
Heteroptera(122)	**Coreidae(122)**	Leptocorisa apicalis,	0	17	40	2
		Leptocorisa varicornus F	0	28	32	3
	Pentatomyidae(54)	Nezaria viridula	0	14	13	27
Thysanoptera(98)	**Thripidae(44)**	Sténchaetothrips biformis	0	0	25	19
Total 7 Orders	16 Famillies	36 Species	184	627	689	432

Out this table, we realize that 36 Species belong to 16families and 7orders. The Species of insects are classified into 5 categories. These results meet with those of [29] in Cameroon and [22] in Mali. All these species belong to the main gnawing and damaging insects of the culture of rice in watered areas of Bugorhe.

We note:

- Gnawing insects which destroy leaves, panicules, and grains(Coleoptera, Orthoptera)
- Sucking insects or stinging insects that suck the sap of then plants((Heteroptera and Hemiptera)
- Parasite and predactor insects (Diptera and Coleoptera)
- Dipping insects that dig out the stalks of the plants (Diptera and Lepidoptera)
- Saprophyte insects feeding on vegetal debris or decays.

Table 4. Other gnawing insects that were collected.

Order	Families	Species
Coleoptera	Meloidae	Myla bris holosericea
	Chysomellidae	Asbecesta cyanipennis Asbecesta senegalensis Cirphis unipuncta
	Coccinellidae	Epilachna Spp Chnootriba neglecta
Hymenoptera	Cynipidae	Biorhiza Spp
Orthoptera	Acridoidae	Locusta migratoria Nomadacris setemfasciata
Thysanoptera	Thripidae	Stenchaetothrips biforis

These species although they are captured accidentally in the field of rice in Bugorge, they are responsible of a lot of damage. Their presence in the area is perceived as sporadic.

Table 5. Frequency of Insects.

Taxa	Frequency			
	Phase1	Phase2	Phase3	Phase4
Nephula depuctalis Guen	0	0	4	11
Chilo zacconius	5	0	2	3
Chillo partellus Swinhoe	0	7	4	1
Marasmia patnalis	1	0	11	0
Maliarpha separatella	0	3	9	10
Nagara aenescens	0	0	10	40.1
Schoenobis bipuctus	2	9	2	3.3
Sesamia calcamistis	11.3	32	7	0
Leptocorisa apicalis	0	0	48	52.08
Leptocorisa varicornis	0	23	26.2	2.4
Sogatella frurrcifera	16.1	29	0	0
Nilaparvata lugens	26.2	8	17	4.2
Nephottetis nigropictus	14	26.4	4	0
Nephottetis bipunctatus F.	22.4	0	0	0
Nephottetis malayanus	0	0	33.6	0
Nezaria viridula	0	26	24	50
Heteronychus oryzae	14.2	44	10.2	4
Schizonycha africana	0	23.4	4	0
Asbecesta cyanipennis	0	8	0	6
Asbecesta senegalensis	0	1.52	6	0
Lema oryzae kum	0	12.1	4.06	10.1
Thrips oryzae will	12	2.03	9	6
Spodoptera mauritia	0	18	1	6.5
Cirphus unipuncta	0.5	0	14	0
Chnootriba neglecta	0	30	15	12
Epilachna spp	2	10	24	8
Mylabris holosericea	0	62.5	0	37.5
Locusta migratoria	0	44	34	0
Diopsis thoracica	3	23	21.3	8.3
Diopsis apicalis	2	7	16	7
Agromysa oryzae	0	2	8	3.3
Orseolia oryzivora	0	59	36.2	5.1
Nomadacris septemfasciata	0	7	12	3
Biorhiza sp	0	0	18.4	21.5
Epilachna spp	0	18.4	37	5
Nezaria viridula	0	26	24	50
Stenchaetothrips biformis	0	0	27	43.1
Chilo suppressalis Walk	0	1	2	4

These are the different species of insects that damage the culture of rice Bugorhe. We notice that the frequency varies according to the variety of rice and the phases of development.

The Incidence of damage due to insects.

The damage caused by the insects is notable in the second (vegetative phase) and in the third (generative phase) of the culture. It is at these phases when the culture putting a flower in button hole and maving to maturating. Insects are very active at the flowering period. The variety of Vo46 is most visited by Diptera, Ceccidomyiidae, Homoptera ,Delphacidae, and Cicadellidae, Heteroptera, Coreidae and Pentatomidae. It is the period for the formation of panicules. On the other hand, the hymenoptera cynidae and the Lepodoptera pyralidae are found on the varieties of *FacAgro56* and *Br14* at the vegetative and the generative phases. For the Coleoptera meloidae, they are found on *Vo46* and *Fac Agro56* at the second and third phases

and the Orthoptera, Acridoidae at the maturation (found phase). The milky spicules are good diet for these insects. The results meet the works of [14], [17], [12], [33], [35] and [20] about the insects damaging the culture of rice along with their biology and dynamics.

Rate of damage and occurrence of attacks

Table 6. The average of damaged of plants are presented in the table below

Varieties	Number of damaged plants				Number destroyed plants				Total number of plants			
	Ph I	PhII	PhIII	PhIV	PhI	PhII	PhIII	PhIV	PhI	PhII	PhIII	PhIV
Vo46	0	7	12	10	0	12	27	10	100	88	73	90
Br14	0	3	0	0	0	0	0	0	100	97	100	100
Vo96	0	5	11	4	0	7	7	25	100	93	93	75
FacAgro56	0	17	4	10	0	0	0	0	100	100	100	100
R12	100	100	100	5	0	3	0	0	100	97	100	100

Legend: PhI= Sprouting phase, PhII= Vegetative, Phase III= generative, Phase IV= Maturation phase. We realize that all the varieties were attacked by the insects at different stages of development. The attacks are very notable on varieties R12, FacAgro56, Vo96, and Vo46.

Table 7. Estimation of the rate damage and the incidence of the attacks during the phases of development of the rice.

Varieties	**Rate of damage**				**Incidence of attacks**			
	PhI	**PhII**	**PhIII**	**PhIV**	**PhI**	**PhII**	**PhIII**	**PhIV**
Vo46	**0**	**7**	**12**	**10**	**0**	**14**	**40**	**11**
Br14	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**
V096	**0**	**5**	**12**	**5**	**0**	**7.5**	**7.5**	**33**
FacAgro56	**0**	**17**	**4**	**10**	**0**	**0**	**0**	**0**
R12	**100**	**103**	**100**	**100**	**0**	**3**	**0**	**0**

Legend : Phase I= Sprouting, Phase II= Vegetative, Phase III= generative, Phase IV= Maturity.

The incidence noticed on the varieties Vo46, and Vo96, are attributed to the sensibility of the varieties to the diseases during the seasonal period B of the year 2013.

Table 8. The incidence of diseases in Bacteriosis , Pyriculariosis, and the Rice Yellow Mottle Virus with regards to the number of Shoots or tillers

Varieties	NTmax	NTS	NTBac				NTPy				NTRYMV				Tu			
			PhI	PhII	PhIII	PhIV	PhI	PhII	PhIII	PhIV	PhI	PhII	PhIII	PhIV	PhI	PhII	PhIII	PhIV
Vo46	24	5	0	0	3	3	0	0	1	2	0	0	1	1	0	5	10	11
Br14	23	20	0	0	1	0	0	0	0	0	0	0	2	2	0	20	23	22
Vo96	21	10	0	0	3	3	0	3	3	2	0	0	2	1	0	13	18	16
Fac Agro56	18	7	0	0	1	1	0	2	2	0	0	0	2	0	0	9	10	8
R12	15	9	0	2	0	3	0	2	3	3	0	2	1	0	0	15	13	15

Lengend: TNmax= Maximum Number of tillers, NTS= Number of Sound tillers, NTBac= Number of tillers diseases by Bacteriosis, NTPy= Number of tillers diseased by Pyriculariosis, NTRYMV= Total Number of tillers of Rice Yellow Mottle Virus. Tu= Useful tillering.

Out of table 8, we notice that shoot of the varieties Vo46, Vo96, and FacAgro56, are the most diseased whereas the other varieties are less attacked.

Table 9. Estimation of damages caused by diseases round sheath of bacteria origin, pyriculariosis and Rice Yellow Mottle Virus.

	NPBac				NPPy				NPRYMV				IBa				IPy				IRYMV			
Varieties	PI	PII	PIII	PIV	PI	PII	PIII	PIV	PI	PII	PIII	PIV	PI	PII	PIII	PIV	PI	PII	PIII	PIV	PI	PII	PIII	PIV
Vo46	0	0	2	2	0	2	3	0	0	0	5	3	0	0	20	20	0	40	30	0	0	0	50	27
Br14	0	0	1	3	0	0	0	0	0	0	2	1	0	0	4	14	0	0	0	0	0	0	9	5
V096	0	0	4	1	0	3	2	0	0	0	1	2	0	0	22	6	0	23	11	0	0	0	5.5	12.5
FacAgro56	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	11	0	0	0	0	0	0
R12	0	0	2	1	0	0	3	0	0	0	0	4	0	0	15	7	0	0	23	0	0	0	0	26.6

Legend: P1= Phase1, PII= Phase 2, PIII= Phase 3, PIV= Phase4.
NPBac= Number of plants infected with bacteria, NPPy= Number of plants infected with Pyriculariosis, NPRYMV= Number of plants infected with Rice Yellow Mottle Virus. IBac= Incidence of Bacteriosis, IPy= Incidence of Pyriculariosis, IRYMV= Incidence of Rice Yellow Mottle Virus.

Out of table 9, we notice how all the varieties of rice are infected with diseases at all the different stages of growth. Two varieties mainly *Vo46*, and *Vo96*, are the most attacked by *bacteriosis*. However, the *pyriculariosis* is observed on the varieties of *Vo46, R12*, and fainly on the varieties *Br14* and *V96*, but the variety *FacAgro56* is resistant to all the different infections. The species of insects such as Pyralidae, mainly *Chilo suppressalis* are vectors of White sheaves disease. Whereas the species of the families of Delphacidae and Cicadellidae such as *Sogatella furrcifera, Nilaparvata lugens*, *Nephottetis migropictus, Nezaria viridula*, *Nephottetis bipunctatus* F are proved to be responsible of the *Rice Yellow Mottle Virus*. The bacterian rotting such as *Pseudomonas fuscovaginae*, and fungus diseases as *Saracladium oryzae, Cerospora janseana, Piricularia oryzae.*

4 CONCLUSION

The results we have obtained show that the different species of insects attack the plants of rice in the irrigated marshy high land of Bugorhe at all the different phases of development of culture f rice. No species of rice is spared from the insects attacks. They don't only destroy the plants of rice but they are also vectors of different diseases such whitish disease of sheaves, Rice Yellow Mottle Virus, the bacterian rottings(*Pseudomonas fuscovaginae*) fungus diseases(*Saracladium oryzae, Cercospora janseana, Piricularia oryzae*).

Indeed, the Vo46, and Vo96 are damaged by Diptera cecidomyiidae, Homoptera Delphacidae and Ciccadelidae, Heteroptera Coreidae and Pentatomidae these species are highly damaged because of their sensibility in the area. The *Pyriculariosis* is observed on the panicules or knots. This is due to the lack of nutrients, enough water and climate ingredients. They are attributed to the selection of rice seeds. As for the Pyriculariosis, on the lever of leaves of all the varieties, this is attributed to sensitiveness of seeds. At last the Orthoptera Acridoidae and the Coleoptera Meloidae attack considerably the FacAgro56, Br14, and R12 for their nutrietents especially at the blooming stage. As the culture of rice is attacked by insects at the different stages, we hope to begin as soon as possible in the early stage of the growth to stage the swarming of insects with regard to the rules of the environment protection.

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