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Resistance of Upland NERICAs and Parents to Rice Weevil and Angoumois Grain Moth

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ABSTRACT

Twenty one rice varieties including 18 upland NERICAs and their parents (two *Oryza sativa* and one *O. glaberrima*) were screened for resistance to two primary storage pests: *Sitophilus oryzae* and *Sitotroga cerealella*, using the "no choice" infestation method. Resistance of rice varieties was assessed based on the adult's population obtained from first generation of each species and also on the weight loss recorded on infested samples. Results revealed that adult progenies from *S. oryzae* and weight loss were very low on paddy and fairly high on husked rice. Results also suggested that glumes are one main parameter conferring the resistance to *S. oryzae*. Differential responses of rice varieties to *S. cerealella* were observed. Of the 18 NERICA tested, NERICA6, 14, 4, 3, 15 and 16 were tolerant in increasing order, whereas only NERICA9 and 11 were susceptible. The *Oryza glaberrima* parent CG 14 was resistant to the insect while the *O. sativa* parents WAB 56-50 and WAB 56-104 were susceptible. Progenies resistance to the insect may have been provided by the parent CG 14. The implications of the findings and the way forward were discussed.

Key words: Post-harvest, NERICA, resistance, tolerance, *S. cerealella*, *S. oryzae*

INTRODUCTION

Rice is the staple food of more than half of the world's population (Africa Rice Center, 2011a). In Sub-Saharan Africa, rice production failed to meet the 6% growth of annual demand (Africa Rice Center, 2011b). In 2009, Africa has spent 5 billion USD in rice import. Rice consumption in West Africa (from 12 to nearly 40 kg per inhabitant in average from 1960-2009) is much higher compare to other regions of Africa (9-21 kg per inhabitant) (Diagne *et al*., 2010). Benin is also importing nearly twice its rice production (70.000-380.000 t relative to year) (Diagne *et al*., 2010). This gap is caused by various biotic and abiotic constraints among which more than 100 species of insects are considered as rice pests included about 20 species that are economically important (Heinrichs, 1992). Grain storage in storehouses to prevent against insect damage is a big issue that are facing householder (Rizwana *et al*., 2011). During storage, rice is vulnerable to a range of insects including the rice weevil *Sitophilus oryzae* (Coleoptera: Curculionidae) and the Angoumois grain moth *Sitotroga cerealella* (Lepidoptera: Gelechiidae) (*S. oryzae*). These insects have a cosmopolitan distribution (Cotton, 1960) and have an affinity for rice varieties with different levels of resistance (Rizwana *et al*., 2011). Losses are estimated around 5-10% of grain yield worldwide (Adam, 1998). Rice post-harvest losses ranged from 30-50% (Helbig, 1997) in tropical countries (such as Benin) known to have hot and humid summer and where storage facilities are improper and inadequate

(Ahmed and Raza, 2010; Rizwana *et al*., 2011). Togola *et al*. (2010) reported that 80% of rice fields were infested by *S. cerealella* in Benin especially in the southern and central climatic regions. In addition, 70% of rice stocks were found infested by *S. cerealella,* with 30-300 insects per kilogram after 2-4 months storage. Chemical control is widely used but often with worse health and environmental consequences. Of the management strategies against storage insect pests, varietal resistance is the most suitable against majority of these pests. However, despite intensive efforts of integrated pest management (varieties development, quality seed production, good field management and appropriate production techniques dissemination), post harvest and storage aspects are often overlooked. Since their development by the Africa Rice Center (AfricaRice), NERICA rice varieties are being widely used by farmers and are cropped under thousands of hectares in several countries (Somado *et al*., 2008; Akintayo *et al*., 2009). They are key components of AfricaRice poverty and hunger alleviation strategy through increase of rice productivity between 0.5-1.1 t ha^{-1} depending of the country in SSA (Diagne *et al*., 2010). However, no study was conducted on the behavior of NERICA varieties in post-harvest storage facilities, mainly with regard to the rice weevil *S. oryzae* and the Angoumois grain moth *S. cerealella*. Thus, the purpose of this study is to generate information on the resistance level of the upland NERICA and their parents to these insects inducing serious losses in farmers' storage facilities.

MATERIALS AND METHODS

The study was conducted in the Laboratory of Entomology at the Africarice Center (AfricaRice) Cotonou/Benin in 2009. The plant material used in this study included 21 rice varieties of which the 18 upland NERICAs, two *O. sativa* varieties (WAB5650 and WAB56104), used as recipient parents in NERICAs development and their male parent (CG14), an *O. glaberrima* variety (Table 1). The paddy samples of these varieties were obtained from the Genetic Resources Unit of Africa Rice. The samples were evaluated for resistance to the rice weevil (*S. oryzae*) and the Angoumois grain moth (*S. cerealella*) using the "no choice" artificial infestation method. The following conditions were maintained in the laboratory during the experiment: Temperature = 25±1°C, Relative humidity = 70±5% and 12/12 h light/dark, for an optimum infestation. Paddy samples of the 21 varieties, at 14% humidity, were cleaned and stored at 4°C for two weeks to kill any undesired insects or mites present in the samples. The insects samples used in this study were strains from Benin and reared in the laboratory.

Method of rice infestation with rice weevil: Samples of 200 grains of rice (paddy and husked rice) of each variety were stored in glass jars (6 cm: diameter×11 cm: height) and the top covered using cloth tissue with aerated lid. Each sample was infested with 20 adults of *S. oryzae* (10 males and 10 females) obtained from the laboratory strain, as described by Sauphanor (1989). The strain of *S. oryzae* used in this study was maintained on a susceptible rice variety for two years at 25±1°C, 70±5% RH, with regular rice stock renewal. At 14 days post-infestation (dpi), insects were removed and samples kept in the experimental conditions for 45 days. The experiment was replicated four times in a Randomized Complete Block Design (RCBD). After completion of the first generation (45 dpi), adult progeny per sample was counted and recorded. Number of damaged grains was separated, counted, weighed and recorded. The weight loss was calculated using the formula of "Count and Weight method" (Adams and Schulten, 1978; Chougourou *et al*., 2013) as follow:

$$P\ (\%) = \frac{axd - cxd}{ax(d+b)} \times 100$$

Where:
a = Weight of undamaged grains
b = Number of undamaged grains
c = Weight of damaged grains
d = Number of damaged grains

Method of rice infestation with Angoumois grain moth: Glass jars (6 cm: diameter×11 cm: height) with top covered with tissue with aerated lid and containing 200 grains of Paddy samples of each variety were used. Eggs were obtained by exposing folded paper (black or grey) booklets to large numbers of adult moths in a glass container for 4 days (oviposition period) (Ellington, 1930; Russell and Cogburn, 1977). When the paper was unfolded, bits of paper with adhering clusters of eggs were then carefully cut from the booklet pages. Collected eggs were counted under a binocular microscope and paper pieces carrying at around 20 eggs were put on each sample jar as described above (Russell and Cogburn, 1977; Sauphanor, 1989; Rizwana *et al.*, 2011; Hamed and Nadeem, 2012). All samples seeded with eggs, were kept under the same laboratory conditions as described above. The experiment was replicated four times using the same design as earlier. Eggs hatched and adult emergence (male and female) were counted and recorded in each treatment after completion of the first generation (40 days). Number of damaged grains were counted, weighed and recorded. The same formula as above was used to estimate the weight loss.

Table 1: List of 21 rice varieties evaluated for resistance to storage pests *Sitophilus oryzae* (Coleoptera: Curculionidae) and the Angoumois grain moth *Sitotroga cerealella* (Lepidoptera: Gelechiidae)

		Type of variety		
Varieties	Varieties pedigree	Caryospsis color	Inter-specific	Intra-specific
NERICA1	WAB 56-104/CG 14//2*WAB 56-104	White	X	-
NERICA2	WAB 56-104/CG 14//2*WAB 56-104	White	X	-
NERICA3	WAB 56-104/CG 14//2*WAB 56-104	White	X	-
NERICA4	WAB 56-104/CG 14//2*WAB 56-104	White	X	-
NERICA5	WAB 56-104/ CG 14//2*WAB 56-104	White	X	-
NERICA6	WAB 56-104/CG 14//2*WAB 56-104	White	X	-
NERICA7	WAB 56-104/CG 14//2*WAB 56-104	White	X	-
NERICA8	WAB 56-104/CG 14//2*WAB 56-104	White	X	-
NERICA9	WAB 56-104/CG 14//2*WAB 56-104	White	X	-
NERICA10	WAB 56-104/CG 14//2*WAB 56-104	White	X	-
NERICA11	WAB 56-104/CG 14//2*WAB 56-104	White	X	-
NERICA12	WAB 56-50/CG 14//2*WAB 56-50	White	X	-
NERICA13	WAB 56-50/CG 14//2*WAB 56-50	White	X	-
NERICA14	WAB 56-50/CG 14//2*WAB 56-50	Reddish	X	-
NERICA15	CG 14/WAB 181-18//2*WAB 181-18	Red	X	-
NERICA16	CG 14/WAB 181-18//2*WAB 181-18	Red	X	-
NERICA17	CG 14/WAB 181-18//2*WAB 181-18	White	X	-
NERICA18	CG 14/WAB 181-18//2*WAB 181-18	Red	X	-
WAB 56-50	WAB 56-50	White	-	X
WAB 56-104	WAB 56-104	White	-	X
CG 14	CG 14	Red	-	X

X: Belonging, -: Not belonging

Statistical data analysis: An analysis of variance (ANOVA), followed by a multiple means comparison using a Student Newman Keuls test at 5% were performed using Genstat 14th version.

RESULTS

Throughout this study the grains moisture content varied from 12-14% and that of the temperature was 25±1°C with 70±5% relative humidity.

Resistance to *S. oryzae*: The type of rice grain (paddy or husked) has an impact on its resistance to *S. oryzae*. Indeed all the evaluated parameters (number of damaged grain, weight loss, insect population size) were significantly (<0.001) different between husked and paddy rice (Table 2). However for the same rice type (paddy or husked), there was no difference in the rice varieties (Table 3). On paddy, no emergence was observed while on husked rice, results revealed the presence of a high number of emerged adult after at 45 dpi. Subsequently, 1% weight loss was recorded for paddy rice, whereas up to 75% was observed for husked rice.

Resistance to *S. cerealella*: No significant difference was found between rice varieties for the number of *S. cerealella* eggs hatched 40 dpi (Table 4). In average, 19.46 out of the 20 eggs have hatched. However, there was a significant difference (p<0.001) between rice varieties for the number of adult insects that were able to develop from eggs hatched.

The highest number moths has emerged from varieties NERICA9; NERICA11 with 8.5, 7.75 individuals, respectively. Varieties NERICA7 and 8 have the same amount of emerged moths (7.5 individuals). While the *O. glaberrima* donor parents CG14 had the lowest individual that have emerged (0.5 individual), followed by varieties NERICA16 and NERICA15 (1.00 individual), NERICA14 (1.5 individual) and NERICA4 (1.75 individual). Recipient *O. sativa* parents WAB 56-50 and WAB 56-104 had 19 and 20 hatched eggs and 5 and 2.5 emerged moths, respectively.

Significant difference (p<0.001) between some varieties was observed for the number of insects in both male and female (Fig. 1). The highest number of female, ranging from 3.5-4.25, was recorded for varieties NERICA9, NERICA8, NERICA17, NERICA7 and NERICA11. At the same time, no female was observed in varieties NERICA6, NERICA16, NERICA15 and the *O. glaberrima* parent CG14 and only few on NERICA4.

As a consequence of the high number of moths that has emerged from them, rice varieties NERICA9, NERICA8, NERICA7, NERICA11 and NERICA12 were the most damaged varieties with 9.50, 8.75, 8.25, 8.25 and 7.50 damaged grains, respectively. Likewise, varieties NERICA15,

Table 2: Combined analysis of variance of resistance parameters of 21 paddy and husked (hereby refer as "Grain Aspect") rice varieties at 45 days after artificial infestation with *Sitophilus oryzae*

		Mean squares		
Source of variation	df	No. of damaged grain	Weight loss	Insect population size
Replication	3	515.4	398.9	1020.2
Variety	20	261.1	429.3	555.1
Grain aspect (Husked or paddy)	1	1359180.5**	61732.1**	517260.0**
Variety (Grain aspect)	20	282.3	436.7	557.0
Residual	123	183.4	411.3	722.7
Total	167			

NERICA16 and their donor parent CG14 with only few emerged insects, obtained fewer damaged grains ranging from 0.5-1.5. The recipient parents WAB 56-50 and WAB 56-104 had 5 and 3.5 damaged grains.

Table 3: Relative resistance of 21 paddy and husked (Grain Aspect) rice varieties at 45 days after artificial infestation with *Sitophilus oryzae*

	Paddy			Husked rice		
Rice varieties	Adult developed (number)	No. of damaged grains	Grains weight loss (%)	Adult developed (number)	No. of damaged grains	Grains weight loss (%)
NERICA1	0.00±0[a]	0.75±0.47[a]	0.37±0.23[a]	134.75±25.10[a]	197.00±1.20[a]	75.38±16.87[a]
NERICA2	0.00±0[a]	0.50±0.28[a]	0.25±0.14[a]	86.250±17.95[a]	160.00±17.17[a]	24.69±5.36[a]
NERICA3	0.00±0[a]	0.75±0.75[a]	0.37±0.37[a]	103.25±23.22[a]	169.50±15.04[a]	22.88±4.19[a]
NERICA4	0.00±0[a]	0.50±0.50[a]	0.25±0.25[a]	110.50±18.35[a]	183.25±7.16[a]	43.99±19.54[a]
NERICA5	0.00±0[a]	1.50±0.86[a]	0.75±0.43[a]	86.000±5.58[a]	170.50±4.57[a]	23.51±3.62[a]
NERICA6	0.25±0.25[a]	0.50±0.50[a]	0.25±0.25[a]	115.00±23.76[a]	182.00±8.09[a]	26.49±11.22[a]
NERICA7	0.00±0[a]	3.25±1.43[a]	0.95±0.35[a]	106.75±27.39[a]	169.25±9.43[a]	26.50±5.93[a]
NERICA8	0.25±0.25[a]	1.50±0.86[a]	0.75±0.43[a]	96.250±31.50[a]	152.25±27.01[a]	39.83±21.56[a]
NERICA9	0.00±0[a]	1.25±1.25[a]	0.24±0.24[a]	92.250±9.43[a]	186.25±3.19[a]	31.90±4.90[a]
NERICA10	0.25±0.25[a]	1.25±0.47[a]	0.62±0.23[a]	104.50±23.60[a]	172.50±15.88[a]	44.53±19.42[a]
NERICA11	0.00±0[a]	1.25±0.75[a]	0.62±0.37[a]	112.00±5.00[a]	191.75±2.42[a]	45.98±19.37[a]
NERICA12	0.00±0[a]	2.00±1.08[a]	0.68±0.27[a]	128.50±6.07[a]	192.25±3.56[a]	42.38±19.27[a]
NERICA13	0.00±0[a]	0.50±0.28[a]	0.25±0.14[a]	97.250±14.65[a]	183.25±6.16[a]	20.26±1.62[a]
NERICA14	0.25±0.25[a]	0.75±0.75[a]	0.37±0.37[a]	108.00±18.70[a]	190.50±3.70[a]	26.50±11.65[a]
NERICA15	0.00±0[a]	0.00±0[a]	0.00±0[a]	129.50±14.31[a]	191.75±2.65[a]	46.29±19.44[a]
NERICA16	0.00±0[a]	0.25±0.25[a]	0.12±0.12[a]	134.00±12.17[a]	185.00±0.70[a]	38.25±5.59[a]
NERICA17	0.00±0[a]	0.25±0.25[a]	0.12±0.12[a]	131.50±32.97[a]	184.75±8.94[a]	59.27±23.69[a]
NERICA18	0.00±0[a]	0.50±0.50[a]	0.25±0.25[a]	122.75±25.91[a]	185.00±7.24[a]	45.75±18.62[a]
WAB 56-50	0.00±0[a]	0.00±0[a]	0.00±0[a]	134.00±11.75[a]	191.25±4.02[a]	65.25±20.23[a]
WAB 56-104	0.25±0.25[a]	0.75±0.47[a]	0.37±0.23[a]	112.00±14.06[a]	185.50±4.09[a]	33.56±3.70[a]
CG14	0.00±0[a]	0.25±0.25[a]	0.12±0.12[a]	086.75±7.12[a]	172.50±3.70[a]	29.68±3.01[a]
Probability (P)	NS	NS	NS	NS	NS	NS

In the same column, means with different letter are significantly different at 5% level (Student Newman Keuls, $p<0.001$), NS: No significant, ±SE: Standard error

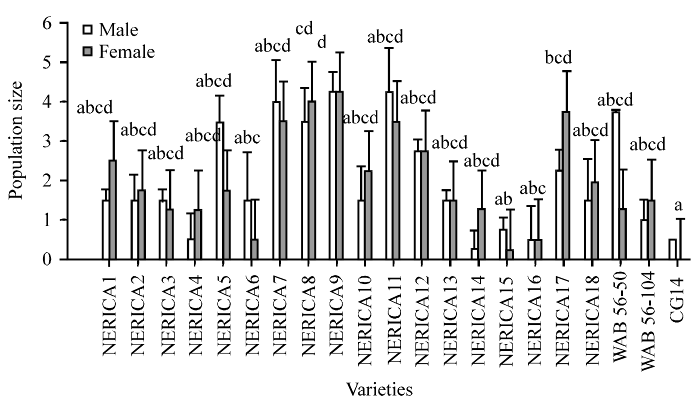

Fig. 1: Repartition of the insect population of *Sitotroga cerealella* by sex after the 1st generation, 40 days after artificial infestation on 21 rice varieties

The highest percentage of weight loss was recorded on NERICA9 (2.49%) followed by NERICA11 (2.15%) and *O. sativa* parent WAB 56-50 (2.11%) while the varieties NERICA15, NERICA16 and the *O. glaberrima* CG14 had the lowest weight loss. A good correlation was observed between the number of emerged moths and the percentage of weight loss (Fig. 2).

Finally it was observed that the number of damaged grains and weight loss of infested samples was relatively low, probably due to the low number of insect progenies that has emerged.

Table 4: Relative resistance of 21 paddy rice varieties at 40 days after artificial infestation with *Sitotroga cerealella*

Varieties	No. of adult developed after 1 generation	No. of eggs hatched	No. of damaged grains	Weight loss (%)
NERICA1	4.00±0.81^{abcde}	19.75±0.25^{a}	4.25±0.85^{abcde}	1.41±0.23^{abc}
NERICA2	3.25±0.62^{abcd}	19.00±0.57^{a}	3.25±0.62^{abcd}	0.87±0.32^{ab}
NERICA3	2.75±1.03^{abc}	20.00±0^{a}	2.75±1.03^{abc}	0.64±0.13^{ab}
NERICA4	1.75±0.47^{ab}	19.50±0.28^{a}	2.25±0.62^{ab}	1.12±0.31^{abc}
NERICA5	5.25±0.94^{abcde}	18.25±1.75^{a}	5.50±1.19^{abcde}	1.14±0.34^{abc}
NERICA6	2.00±0.70^{ab}	20.00±0^{a}	2.00±0.70^{ab}	1.00±0.35^{abc}
NERICA7	7.50±0.28^{de}	20.00±0^{a}	8.25±0.47^{cde}	1.43±0.22^{abc}
NERICA8	7.50±1.19^{cde}	19.25±0.75^{a}	8.75±1.65^{de}	1.65±0.23^{abc}
NERICA9	8.50±1.32^{e}	20.00±0^{a}	9.50±1.65^{e}	2.49±0.35^{c}
NERICA10	3.75±1.43^{abcd}	19.75±0.25^{a}	4.25±1.31^{abcde}	1.74±0.31^{abc}
NERICA11	7.75±1.31^{de}	18.50±0.86^{a}	8.25±1.54^{cde}	2.15±0.14^{bc}
NERICA12	5.50±2.39^{abcde}	20.00±0^{a}	7.50±2.75^{bcde}	1.88±0.61^{abc}
NERICA13	3.00±0.40^{abcd}	19.50±0.5^{a}	3.75±1.10^{abcd}	1.22±0.16^{abc}
NERICA14	1.50±0.95^{ab}	20.00±0^{a}	2.25±1.43^{ab}	0.78±0.45^{ab}
NERICA15	1.00±0.70^{ab}	19.50±0.5^{a}	1.50±0.64^{a}	0.75±0.32^{ab}
NERICA16	1.00±0.40^{ab}	20.00±0^{a}	1.00±0.40^{a}	0.50±0.20^{ab}
NERICA17	6.00±1.22^{bcde}	20.00±0^{a}	6.00±1.22^{abcde}	1.51±0.07^{abc}
NERICA18	3.50±0.86^{abcd}	19.75±0.25^{a}	4.75±1.65^{abcde}	1.27±0.59^{abc}
WAB 56-50	5.00±0.81^{abcde}	19.00±0.70^{a}	5.00±0.81^{abcde}	2.11±0.24^{bc}
WAB 56-104	2.50±0.50^{ab}	20.00±0^{a}	3.50±0.86^{abcd}	1.38±0.51^{abc}
CG14	0.50±0.50^{a}	17.00±1.91^{a}	0.50±0.50^{a}	0.25±0.25^{a}
Probability (P)	$p<0.001$	NS	$p<0.001$	$p<0.001$

In the same column, means with different letter are significantly different at 5% level (Student Newman Keuls, $p<0.001$), NS: No significant, ±SE: Standard error

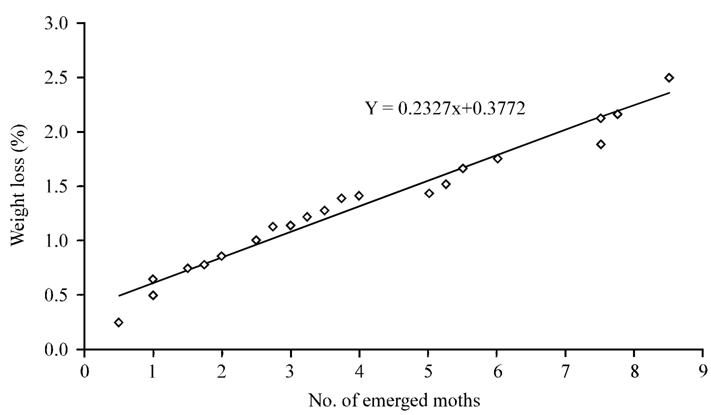

Fig. 2: Correlation between the number of *Sitotroga cerealella* that has emerged at 40 days after artificial infestation and the percentage of weight loss in 18 NERICA rice varieties and their three parents

DISCUSSION

Resistance to *S. oryzae*: With *S. oryzae*, the 18 NERICA varieties and their parents did not show any significant difference in terms of number of emerged adults, damaged grains and weight loss for paddy and husked rice. These results clearly indicated that intact hulls of rough rice (paddy) can limit damage and oviposition of rice weevils. These results confirmed those of Breese (1960), Cogburn (1974), Sauphanor (1989), Kossou *et al.* (1993) and Chanbang *et al.* (2008a), reporting that the rough rice hull offers protection from insects and any break in the hull could provide an access point for stored-product beetles such as *S. oryzae*. This resistance of paddy can be explained by the physical hardness of rice husks which constitute barriers to insect development (Cogburn, 1977; Prakash, 1982; Ishtiq *et al.*, 1997; Lohar *et al.*, 1997; Shafique and Ahmad, 2003; Shafique and Chaudry, 2007). Hull morphology was thus considered as an unreliable base of resistance to insects species (Cogburn *et al.*, 1983). However, Russell and Cogburn (1977) suggested that more than one mechanism operate against the insects and that the development of insects is slow on resistant varieties. Accordingly, all NERICAs are tolerant to *S. oryzae* when stored as paddy at least during the 45 days used in this study. However, as husked grains, all varieties may become susceptible to *S. oryzae* during 45 days of storage.

Resistance to *S. cerealella*: With *S. cerealella*, the technique of egg infestation was appropriate as shown by the high percentage of egg hatched. Percentage of weight loss and number of adult progeny appeared to be good indications of paddy rice resistance (El-Dessouki and El-Kifl, 1976; Sardar, 1976; Chatterji *et al.*, 1977; Cogburn, 1977; Khattak and Shafique, 1981; Mohapatra and Khare, 1989). On the number of emerged adult progenies and grain damage basis, paddy NERICA9, NERICA8, NERICA7, NERICA11, NERICA12 and *O. sativa* parent WAB 56-50 showed the highest susceptibility among the tested cultivars. Conversely, it appeared that NERICA15, NERICA16 and CG14 (*O. glaberrima*), all with red caryopsis, had a good resistance. Of the eggs hatched only few had reach adult level on these varieties, suggesting again that rice glumes serve as barrier for entry of larvae into the grains (Cogburn, 1974). However, glumes solely cannot explain this observation but rather many factors should be taken altogether. Among those factors, Breese (1960), Dobie (1974), Russell (1976), Serratos *et al.* (1987), Irshad *et al.* (1988), Ratnadass and Sauphanor (1989), Sauphanor (1989), Chanbang *et al.* (2008b), Ahmed and Raza (2010) and Chougourou *et al.* (2013) stated that physico-chemical such as kernel hardness, husk protection, kernel size and texture and the consistency of the grain envelop, genetic and environmental conditions as the main properties helping cereals to resist against insect pests. Indeed, similar studies conducted by Cogburn (1974) and Russell and Cogburn (1977), indicated that physical and morphological characters may confer resistance in combination with some other factors particularly the biochemical ones. Russell (1968) and Cohen and Russell (1970) came upon the same conclusion with respect to attack by Angoumois grain moth and by the maize weevil, *Sitophilus zeamais* Motschulsky. Moreover, Rizwana *et al.* (2011) reported that the development of *S. alella* was positively and significantly correlated with the moisture content of the grain. These results are similar to those of Prakash *et al.* (1979), Hameed *et al.* (1984) and Hamed and Nadeem (2012) who reported that the most favorable range of moisture is 12-18% for a range temperature of 21-32°C which corresponded to the environmental fluctuations in our study.

The percentage of weight loss recorded for this test was around 2.49%. The test took into account only one generation of *S. alella* which could explain the low rates recorded. There was a very low weight loss on the parent glaberrima GC14 (0.25%), confirming the hypothesis raised by

Sauphanor (1989), that only *Oryza glaberrima* and few indica show a good level of resistance to *S. alella*. Except for NERICA18 at the progenies with red caryopsis were resistant to the insect suggesting a genetic basis for the observed phenomenon.

However, none of the NERICA with red caryopsis was as resistant as the *O. glaberrima* parent, suggesting that some other genetic determinism, specific to *O. glaberrima* background, may play a role in the resistance.

CONCLUSION

This study has allowed assessing the level of resistance of NERICA rice varieties and their parents against *S. oryzae* and *S. alella*. It appeared that paddy grain of all the tested varieties showed resistance to *S. oryzae*. However, in husked state, all varieties were susceptible except the *O. glaberrima* parent CG14 which was tolerant. As for *S. alella*, CG14 and most of the red caryopsis (except for NERICA18) and some white caryopsis NERICAs varieties such as NERICA6, NERICA4 and NERICA3 showed very good tolerance. While the remaining and the *O. sativa* parents were moderately tolerant or susceptible. These findings suggested the existence that the tolerance of the tested rice varieties to *S. alella* is under genetic control. Furthermore, it could be associated with factors more predominant in *O. glaberrima* (like CG14) species than *O. sativa*. These factors could be related to secondary metabolites compounds (Wink, 1988).

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