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Susceptibility of some Rice Varieties to the Lesser Grain Borer, *Rhyzopertha dominica* Fab. (Coleoptera: Bostrichidae) in Benin

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Abstract: The lesser grain borer, *Rhyzopertha dominica,* is a major primary insect of stored cereals worldwide. In Benin, it causes serious damages on paddy rice stored in rural zones. Nowadays, there is a big interest in developing alternative measures included the use of resistant varieties for controlling this key pest. For this purpose, a study was conducted at Africa Rice Center in 2008 to establish the resistance of 17 improved rice varieties included 13 NERICA, 2 *Oryza sativa* and 2 *Oryza glaberrima* to this pest. The varieties were artificially infested under laboratory conditions. The results showed that CG14, WAB56-50, WAB56-104 and NERICA4 had good resistance against the attack of *Rhyzopertha dominica* while NERICA10 and NERICA8 were highly susceptible. The most tolerant cultivars investigated from this study could be recommended for safe storage to reduce pest and economic losses in all endemic zones where *R. dominica* represents a major threat.

Key words: Resistance, NERICA, *Rhyzopertha dominica*, *Oryza glaberrima*, *Oryza sativa*

INTRODUCTION

Among the world top three cereals (wheat, rice and corn), rice has the highest cultivated area (Sie, 1991). It is grown on about 149 million hectares with an approximate production of 380 million tons. It is the third consumed crop after wheat and corn and represents the basic food for over half of the world population (FAO, 2004). In 2005, the world production reached 600 million tons of paddy rice (Del Villar, 2006). In Benin, rice production increased from 22.259 tons to 52.441 tons between 1996 and 2000 and carries on growing steadily during the following years (Adegbola and Singbo, 2005).

In many African countries, there is a large gap between production and consumption. To fill this gap, national and international research institutes have created high yielding varieties in order to boost the local production of rice. By the way, Africa Rice Center has developed new rice varieties called NERICA (New Rice for Africa). These varieties, resulting from the genetic crossing between African and Asian rice species, combine the best characteristics of both parents and are more productive than the local varieties (WARDA, 2000). Moreover, many studies attested that NERICA varieties have good resistance against various African pests (Agunbiade *et al*., 2009; Nwilene *et al*., 2011; Togola *et al*., 2011, 2012). However, the resistance of these varieties to the grain lesser borer, a major pest of stored cereals in Tropics (Nikpay, 2006), is not yet investigated.

The present study aims to assess the resistance of some NERICA varieties to *Rhyzopertha dominica* Fabricius (Coleoptera: Bostrichidae) prior to their on-farm dissemination in Africa.

MATERIALS AND METHODS

The experiment was carried out in 2008 at the Entomology Laboratory of AfricaRice (Benin) where an artificial screening of rice varieties was made for their resistance to *R. dominica*. All experiments were conducted at laboratory conditions of 28°C, 70% RH and 12/12 photoperiod.

Culture of insects: The culture of rice sample was established to supply similar aged *R. dominica* for the experiments. For the purpose, infested rice samples were collected from AfricaRice store room, sieved several times to remove all lesser grain adults, put in 10 jars with 2 L capacity each and kept in laboratory conditions. A 10 cm diameter hole was made in the cover of the jars to allow aeration. The holes were covered with metallic net to

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prevent escape of the insects. Seven days later, same generation *R. dominica* adults were collected from the jars and used as experimental material.

Screening technique: Samples of 17 rice varieties were infested with seven-day-old adults of *R. dominica*. A total of 20 adults were isolated from a laboratory culture by sieving. They were placed in a jar containing 100 g of paddy grains of each variety. Cylindrical polystyrene jars of 10.5 cm diameter and 8 cm height with a screen cover were used for the purpose. Each jar was labelled with the name of the variety and the storage date. It was kept in the laboratory for a period of 2 to 3 months. The jars were arranged in a Randomized Complete Block Design (RCBD) where each treatment was replicated 3 times. The seventeen varieties used for the experiment were composed of:

- **Thirteen NERICA varieties:** NERICA (1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13 and 14) -Two Asian parents (*O. sativa*): WAB56-50 and WAB56-104
- **Two African varieties (*O. glaberrima*):** CG14-06 and TOG71

The grains used in the experiment were previously submitted to the waterline in order to identify and eliminate the abnormal grains (holed or shrivelled).

Data collection and statistical analyses: The data collected include the population of insects, the number and weight of damaged grains. These data were recorded after the second and third months of storage. Finally, the weight loss due to insect infestation was calculated for each storage period using the formula of "Count and Weigh Method" (Adams and Schulten, 1978):

$$\text{Weight loss}(\%) = \frac{(a \times d) - (c \times b)}{a \times (d + b)} \times 100$$

where, a is the weight of undamaged grains, b is the number of undamaged grains, c is the weight of damaged grains and d is the number of damaged grains.

Data were analysed using GenStat Discovery 3 program, version 4.24DE (PC/Windows XP) (Genstat Discovery 3, 2007). The number of damaged or attacked grains and the number of living insect at each period were submitted to ANOVA analysis. Before the analysis, the weight loss was transformed into decimal logarithm values.

RESULTS

Population of *R. dominica* after 2 and 3 months of storage: After 2 months of storage, NERICA varieties showed highly significant difference ($p<0.001$) of the living population of *R. dominica*. Indeed, the living insects were more abundant in NERICA10, NERICA8, NERICA2 and NERICA13 with 27.407, 21.66, 18.82 and 13.72 individuals respectively (Table 1). Also, the difference of total population of *R. dominica* shown by the various NERICA was also significant. The most infested varieties were NERICA8, NERICA10 and NERICA2 with 47.50, 45.55 and 34.11 individuals, respectively as shown in Fig. 1.

After three months of storage the varieties showed also highly significant difference of living population of *R. dominica*. NERICA1 and NERICA10 recorded the highest number with 81.0 and 35.93 insects respectively. At the same period, the two parents WAB56-50 and CG14 didn't record any living insect (Table 1). Concerning the total population three NERICA varieties (NERICA1, NERICA8 and NERICA10) were highly infested by *R. dominica* with 125.67, 83.33 and 62.96 individuals respectively. Three other varieties (WAB56-50, CG14 and NERICA11) had low population varying between 20 and 22 individuals (Fig. 1).

Damages due to *R. dominica* infestation after 2 and 3 months of storage: After two months of storage, there was a significant difference between tested NERICA varieties in terms of mean number of damaged grains. The most damaged varieties were NERICA8, NERICA10 and NERICA13 that recorded 226.85, 69.26 and 64.31 grains respectively, while WAB56-50, NERICA4 and CG14 showed the lowest number of damaged grains with 0.67, 2.33 and 5.21 grains respectively. The remaining varieties were moderately tolerant to *R. dominica* (Table 1).

Like the previous parameter, the weight loss showed the same trends at that period. NERICA8 recorded the highest weight loss with an average of 1.98% while WAB56-50 and NERICA4 showed the lowest

Table 1: Population of *Rhyzopertha dominica* and damaged rice grains 2-3 months after infestation at 28°C, 70% RH

	Mean No. of damaged grains		Population of living insect	
Varieties	2 month	3 month	2 month	3 month
NERICA10	69.26^{b}	85.56^{ab}	27.407^{a}	35.93^{b}
NERICA3	22.33^{cd}	29.00^{bcs}	8.33^{cdef}	8.00^{bc}
NERICA2	48.24^{bc}	38.82^{bc}	18.824^{abc}	7.06^{bc}
NERICA13	64.31^{b}	38.04^{bc}	13.725^{bcd}	15.29^{bc}
NERICA1	27.33^{cd}	136.67^{ab}	11.000^{bcde}	81.00^{a}
NERICA8	226.85^{a}	150.00^{a}	21.667^{ab}	35.83^{b}
NERICA4	2.33^{d}	19.00^{bc}	0.333^{ef}	1.33^{c}
NERICA7	19.33^{cd}	42.67^{bc}	5.333^{def}	19.67^{bc}
NERICA11	7.67^{d}	19.67^{bc}	2.333^{ef}	1.67^{c}
WAB56-104	8.00^{d}	9.67^{bc}	3.333^{def}	5.00^{c}
NERICA6	12.08^{d}	18.75^{bc}	7.500^{def}	10.00^{bc}
NERICA12	14.67^{d}	6.00^{bc}	1.33^{ef}	2.67^{c}
NERICA14	25.56^{cd}	13.33^{bc}	2.778^{ef}	1.11^{c}
CG14	5.21^{d}	0.00^{c}	0.000^{f}	0.00^{c}
NERICA9	12.69^{d}	44.67^{bc}	1.333^{ef}	19.00^{bc}
WAB56-50	0.67^{d}	0.00^{c}	0.000^{f}	0.00^{c}

Values with same letters in the same column are not significantly different to LSD test

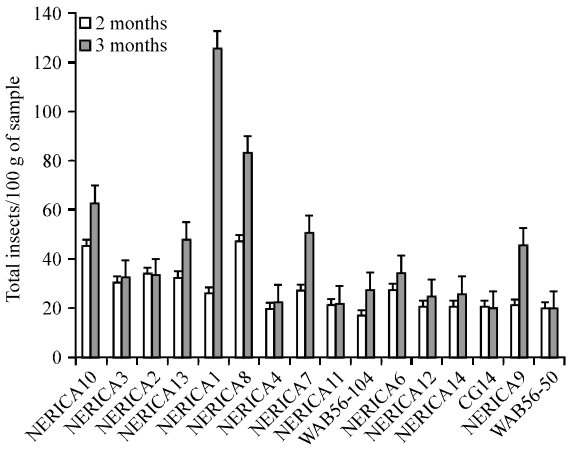

Fig. 1: Growth of *Rhyzopertha dominica* population during the 2nd and the 3rd months of storage

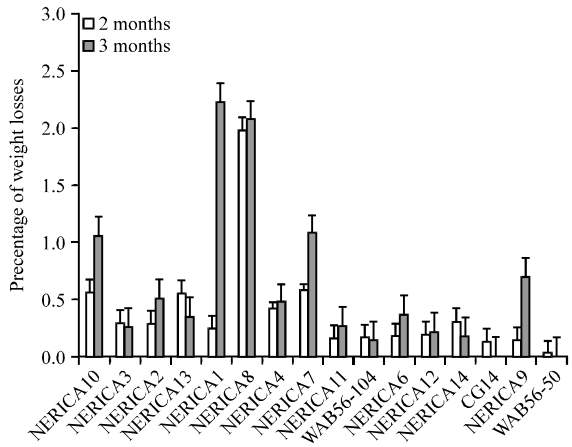

Fig. 2: Weight loss of grains during the 2nd and 3rd months of storage

percentage weight loss (0.022, 0.031%, respectively). The remaining varieties were moderately tolerant (Fig. 2).

After three months of storage, the infested grains significantly varied according to rice varieties. NERICA8, NERICA1 and NERICA10 were the most damaged varieties with 150.0, 136.67 and 85.56 damaged grains respectively. In the same period CG14 and WAB56-50 did not show any damaged grains. Intermediate susceptibility was observed with the remaining varieties that showed moderate damage of grains (6.00 to 44.67 grains) (Table 1). Concerning the percentage of weight losses, it showed the same trends as the number of damaged grains (Fig. 2).

DISCUSSION

According to the results achieved so far, the tested varieties showed a high variability in terms of tolerance to *R. dominica*. NERICA8, NERICA11, NERICA10 and NERICA13 showed the highest susceptibility to the lesser grain borer. After 3 months of storage the insect population reached the highest density and level of grains damage. However, some varieties such as WAB-56-50, WAB-56-104, CG14 and NERICA4 showed a very low population of insect. This situation may be due to many factors but the genetic, physical, morphological and biochemical properties of the varieties could be considered as the predominant ones. Indeed, similar studies have been conducted by Ratnadass and Sauphanor (1989), Sauphanor (1989), Chanbang *et al.* (2008) and Ahmed and Raza (2010) stated that the fitness of rice varieties plays an important role in the attack of harmful insect. These findings agree with those obtained by Breese (1960), Cogburn (1974), Dobie (1974), Serratos *et al.* (1987) and Chanbang *et al.* (2008) that cited Kernel hardness, husk protection, kernel size and texture and the consistency of the grain envelop as the main physical properties helping cereals to resist against insect pests. Similarly, Khattak *et al.* (1996), Ahmed *et al.* (2002) and Shafique and Chaudry (2007) reported that morphological and physical properties play an important role in the natural varietal resistance against a big range of insects included *Rhyzopertha dominica*. Moreover, rice plant resistance level to *R. dominica* may be due to high amylose content of the grains (Ashamo and Khanna, 2006).

Also, the environmental conditions can influence the growth of *R. dominica* population and can consequently allow the attack of rice grains by the insect. In this study, the laboratory conditions (25±1°C and 70±5 % RH) would certainly have encouraged the proliferation of *R. dominica*. As reported by Kranz *et al.* (1977) and Paliwal *et al.* (2004), the life cycle of this insect is limited to 45 days at 27 °C and 70% RH. In these conditions, the second and third generations could easily emerge during 2 and 3 months of storage.

The damage due to *R. dominica* (number of damage grains and weight losses) followed the same trend like the population growth of the insect. NRICA8 and NERICA10 have recorded the highest percentage of weight losses as they did with insect population during 2 and 3 months of storage. Also, NERICA1 and NERICA9 which displayed a good tolerance until 2 months of storage became susceptible after 3 months. Then, these four varieties could be classified as susceptible to *R. dominica*. Contradictory, it appeared that WAB-56-104, WAB56-50 (the Asian parents) and CG-14 (the African parent) recorded very low weight losses. These varieties would have a good resistance to *R. dominica*. Also several NERICA varieties, especially NERICA4, NERICA11, NERICA6, NERICA14 and NERICA3 were highly or

moderately tolerant to *Rhyzopertha dominica*. They certainly would have inherited a resistance gene from their parents.

CONCLUSION

The present investigation showed that NERICA varieties are more susceptible to *R. dominica* than their parents WAB56-50, WAB56-104 and CG14. Also some varieties such as NERICA4, NERICA11, NERICA6, NERICA14 and NERICA3 showed very good tolerant to *R. dominica* as well as the parents. On the other hand, NERICA8, NERICA10, NERICA13, NERICA1 and NERICA9 were susceptible to *R. dominica*.

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