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Sitophilus Weevil Reaction in Upland Rice Elite Lines

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Abstract

Insects of the genus *Sitophilus* are among the most destructive pests in rice storage, and the best strategy to control it is to use resistant genotypes. In this study, 26 upland rice elite lines were evaluated for *Sitophilus* weevil reaction on grain weight. The seeds were placed in plastic recipients stored in a room with temperature and lightning simulating a warehouse environment. The number of living weevils and the grain weight were obtained in two evaluations, one 35 days after storage, and the other 35 days after infestation. The lines differed statistically for number of living weevils and for grain weight in both evaluations. The correlations between these two characters were −0.99 and −0.47 for the first and the second evaluation ($P < 0.05$), respectively. The lines BRS Pepita, AB 112089 and AB 112090 were the most susceptible. Seventeen of the twenty-six elite lines were resistant in both evaluations and could be successfully used in upland rice breeding programs.

Keywords

***Oryza Sativa* L., Insect Resistance, Rice Weevil, Plant Breeding**

1. Introduction

Rice (*Oryza sativa* L.) is one of the most cultivated crops in the world and an excellent source of carbohydrates and protein of human feeding. It is consumed by more than half of the world's population and it is especially important in development countries such as Brazil, playing a strategic role in economic and social politics [1].

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The world rice production was nearly 724 millions of tons in 2014 [2]. Brazil is the only non-Asian country that is among the ten biggest producers of rice, producing almost 12,400 millions of tons in 2344 hectares in the 2014/2015 growing season [3].

According to Campos [4], 20% of the Brazilian annual grain production is lost during the period between harvesting and storing, occurring mainly because of the pests attack during storing. The seeds attacked by insects normally present lower vigor due to the consumption of their reserves, and may even start fermentation and favor fungus development [5] [6].

The incidence of storage grain pests can start on the field, during seeds' development and maturing, or after harvesting, during storage, when environmental is favorable or when there is no insect control. Among the storage grain pests, the weevils of *Sitophilus* genus (Coleoptera: Curculionidae) deserve special attention due to their importance in rice crop, reducing around 20% of yield production when there is no control of this pest or when the cultivar is susceptive [7] [8]. Upland rice usually is more damaged than irrigated rice, because it has a bigger proportion of malformed grains that greatly favor storage pest attack. The major damages are grain weight reduction, commercial depreciation, poorer germination and nutrient loss.

The best strategy to control rice weevil is to use resistant lines, because it reduces the use of insecticide, the costs of production and grain contamination [7]. Therefore, the aim of this study was to evaluate the performance of rice elite lines in the presence of insects of *Sitophilus* genus in order to select resistant lines to be incorporated in upland rice breeding programs.

2. Material and Methods

The experiment was carried out at the Federal University of Mato Grosso (UFMT), Sinop-MT, Brazil (11˚51'49"S, 55˚28'57"W). Twenty-six inbred lines from the Upland Rice Breeding Program from "EMBRAPA" (Empresa Brasileira de Pesquisa Agropecuária) were evaluated for grain weight and number of living *Sitophilus* weevils following a completely randomized design with five replications. These lines were the ones with best performance for several agronomic traits in the field trials carried out by the Brazilian Upland Rice Breeding Program. The plot consisted of a plastic recipient (500 mL) containing 250 grams of freshly harvested seeds for each genotype. Little holes were made on the cover to allow gases passage, and the recipients were stored in a room with lightening and temperature simulating a warehouse environment (30˚C - 32˚C).

A first evaluation was performed 35 days after storing in order to determinate the level of infestation from the field. The procedure consisted of the counting of the number of living *Sitophilus* weevils and plots weighting. Then, the plots were treated with the insecticide Gastoxin® and any speck was cleaned. A 200 grams sample of each plot was infested with ten adults *Sitophilus* weevils and returned to storage. A second evaluation was performed 35 days after infestation using the same procedure described before.

Analyses of variance were computed using the statistical software SAS [9], transforming the number of weevils data to log of x + 1. Genotype's means were compared using the Scott-Knott approach [10] with a probability of 95%. Lastly, the phenotypic correlation between the number of weevils and grain weight were obtained for each evaluation using MSTAT-C software [11].

3. Results and Discussion

Highly significant differences ($P < 0.05$) among genotypes were detected for both characteristics. All experimental accuracies were higher than 84%, indicating high experimental precision [12].

The number of living weevils and grain weight from both evaluations and the Scott-Knott test result are presented in **Table 1**. Considering the first evaluation, the lines "BRS Pepit", "AB 112089" and "AB 112090" had more than 190 weevils and grain weight reduction, suggesting that these lines were more susceptible to weevil infestation from the field. The other genotypes were considered resistant to the field infestation since they did not have grain weight reduction.

Considering the second evaluation, performed after the provoked infestation, seven of the 26 genotypes had a high level of infestation, with more than 100 weevils (**Table 1**). However, only three were truly susceptible, showing significant grain weight reduction. the lines "BRS Pepita", "AB 112089" and "AB 112090" maintained their susceptibility in the second evaluation, suggesting that these lines were also sensitive to weevil attack during storage.

Table 1. Means of living weevils (LW1) and grain weight (GW1) from the first evaluation, and living weevils (LW2) and grain weight (GW2) from the second evaluation on the 26 upland rice lines.

Genotypes	LW1[1]	GW1[1]	LW2[1]	GW2[1]	Lost (%)
Chorinho	3.60 a	250.00 a	14.40 a	200.00 a	0
AB 072007	21.80 a	250.00 a	41.80 a	190.60 a	4.7
AB 072044	0.60 a	250.00 a	13.40 a	199.00 a	0.5
AN Cambará	6.00 a	250.00 a	73.60 a	198.00 a	1
Carolino	0.60 a	250.00 a	5.80 a	200.00 a	0
AB 112093	5.20 a	250.00 a	6.40 a	186.80 b	6.6
BRS CIRAD 302	0.40 a	250.00 a	0.40 a	200.00 a	0
AB 072063	0.20 a	250.00 a	17.40 a	200.00 a	0
BRS Primavera	0.20 a	250.00 a	39.60 a	199.00 a	0.5
BRS Esmeralda	0.00 a	250.00 a	12.20 a	179.80 b	10.1
AB 112108	3.00 a	250.00 a	8.60 a	200.00 a	0
AB 072085	16.00 a	250.00 a	20.40 a	195.20 a	2.4
AB 072047	6.40 a	250.00 a	121.80 b	198.40 a	0.8
BRS Pepita	232.00 c	246.00 b	154.20 b	181.00 b	9.5
AB 112092	7.40 a	250.00 a	0.80 a	196.20 a	1.9
BRS Sertaneja	0.20 a	250.00 a	12.00 a	200.00 a	0
AB 072041	0.20 a	250.00 a	5.60 a	200.00 a	0
AB 112089	236.20 c	245.60 b	175.20 b	182.00 b	9
AB 082022	1.00 a	250.00 a	122.40 b	198.60 a	0.7
H5	10,20 a	250.00 a	75.60 a	197.80 a	1.1
AB 112090	193.20 b	246.20 b	130.40 b	169.00 c	15.5
AB 072035	3.60 a	250.00 a	61.20 a	199.20 a	0.4
AB 072001	43.60 a	249.60 a	107.40 b	191.40 a	4.3
AB 1120172	10.00 a	250.00 a	53.00 a	198.20 a	0.9
AB 072083	0.00 a	250.00 a	15.00 a	200.00 a	0
AB 082021	3.60 a	250.00 a	179.00 b	193.80 a	3.1
Mean	30.97	249.51	56.45	194.39	
Accuracy (%)	98.48	91.93	84.76	93.58	

[1]Means followed by the same latter in the column do not differ significantly by the Scott-Knott test with a probability of 95%.

The incidence of weevils and its effect on rice grains quality can start on the field, during seeds' development and maturing, or after harvesting, during storage, when environmental has favorable conditions or when there is no insect control [13]. Therefore, it is essential to identify rice genotypes with resistance to pests attack before harvesting.

It is important to emphasize that most of the lines evaluated in this study are elite lines from advanced generations of the EMBRAPA Upland Rice Breeding Program, in which some are candidates to became new commercial cultivars, with good agronomic traits and grain quality. Since most of the lines showed resistance to weevil attack, they can be successfully used in programs aiming to obtain new cultivars to the MatoGrosso state, espe-

cially the ones that showed lower percentage of losses in productivity, like the lines "Chorinho", "Carolino", "AB072063", "AB112108" and "BRS Sertaneja".

According to Gallo *et al.* [14], the insect growing and infestation depend directly on the environmental temperature, as the optimal temperature for weevils' development range between 25˚C to 33˚C. The mean temperature on the region where this study was carried is around 30˚C, which allows the rapid increase in the insect population during storing, damaging rice grains and reducing its marketing value.

Puzzi [15] discuss that insects eat seed's endosperm first, and the embryo after, reducing seed's weight and nutrients and affecting its germinate power. The arrangement of grain's palea and lemma can favor the resistance to rice weevil attack, since well-formed grains have less attack than malformed ones [16]. Therefore, it is important to study the arrangement of the grain structures from the different genotypes to testify their resistance.

The correlations between the number of living weevils and grain weight were significant ($P < 0.05$), negative and with large magnitude, −0.99 for the first evaluation and −0.47 for the second evaluation. These results suggest an important association between these characters, as the higher the weevil infestation, the higher the loss on grain weight.

4. Conclusion

According to the evaluations of the number of living weevils and the effect of the infestation on grain weight, it is possible to infer that the most susceptible lines are "BRS Pepita", "AB 112089" and "AB 112090". Seventeen of the twenty-six elite lines are resistant in both evaluations and can be successfully used by upland rice breeding programs in order to obtain new cultivars to Mato Grosso State, Brazil.

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