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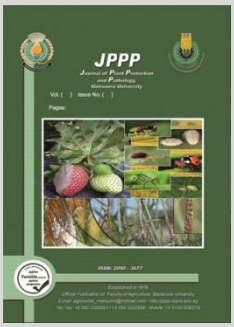
The Effect of different Host Grains on the Biological Aspects of the Lesser Grain Borer *Rhyzopertha dominica* (Fab.) (Bostrichidae: Coleoptera)

Awadalla, S. S.; Hala A. El-Serafi; A. A. Ghanim and Mona M. Shalaby*

Economic Entomology Dep., Faculty of Agri, Mansoura Univ.



ABSTRACT

Laboratory experiments were conducted in Economic Entomology Department, Faculty of agriculture, Mansoura University and used non- choice test to evaluate some biological aspects of *Rhyzopertha dominica* on different host- grains and by One-way ANOVA statistical test to understand if the differences were significant or non-significant based on the host grains then a chemical analysis was done to investigate the most effective chemical ingredient on the susceptibility of *R. dominica*. The results showed that *R. dominca* reared on wheat grains have the shortest development period (25.40 ± 0.75, days) and the highest progeny for the first and second generations (46.80 ± 0.73 and 76.20 ± 4.27, individuals.) Comparing with the other host grains. and wheat was the most susceptible host grain with susceptibility index (15.19 ± 0.39). percentage of protein, fibers, fats, ash, magnesium, zinc, and iron affect the biological aspects of *R. dominica.* The results indicated that there is a relationship between biological characteristics, the insect's ability to cause damage, and the type of host grains, as well as their chemical composition.

Keywords: Host Grains; biological aspects; *Rhyzopertha dominica*; constant temperature.

INTRODUCTION

The Poaceae family is one of the top plant families. It is also one of the most significant food sources in the world because it contains many plant species that are used to feed animals and poultry, as well as cereal crops that are a major source for human feeding. (Wheat, Maize, Rice, and Oats), which people consume throughout the day and consume in very large quantities throughout the year, and some countries resort to importing them annually to meet the people's need for them. (Sarwar *et al*., 2013 and Shavanov, 2021) Stored grains are one of the most important products that people and animals depend on in their daily lives (Sarwar *et al*., 2013).

Pests are estimated to destroy between 7% and 50% of all crops each year. (Pimentel and Rattan 2009; Sallam and Bothe 1999; Calliney *et al.* 2014; Oliveira *et al.* 2014). These insects also have an impact on the quality of grains, their nutritional content, and their suitability for human or animal consumption. (Stathers *et al.* 2020).

One of the most important insects that infests many types of stored grains in Egypt is the lesser grain borer *Rhyzopertha dominica*. This insect is found in most countries of the world. It belongs to the order Coleoptera family (Bostrichidae). This insect is considered one of the primary and dangerous insects that infect stored grains such as wheat, rice, and maize. This insect is classified as an internal primary pest being a borer. The development occurs in grain mass due to its adaptability and high vital capacity (Pires and Nogueira, 2018).

The female lays an egg on the kernel of the grain and the newly larvae swings in the nucleus and completes its growth. The adult feeds on the seed of the grain when it reaches maturity The adult stage punctures the nucleus, creating an exit hole. Then the kernel of the grain is classified as damaged kernel due to insects grading purposes (Mason *et al*., 2012). Outbreak *R. dominica* causes direct product deterioration and indirect economic loss through product rejection due to injury and costs associated with eliminating the injury. Another hidden loss negative effects on grain quality often go unreported as a result for nutritional damage caused by *R. dominica*. (Arthur *et al*. 2020).

The present experiment aims to investigate the effect of different host-grains on the biological aspects of the lesser grain borer *R. dominica* under laboratory conditions.

MATERIALS AND METHODS

The present study was carried out in the laboratory of Entomology belonging to the Economic Entomology Department, Faculty of Agriculture, Mansoura University for two years 2021 and 2022.

Insect culture

On wheat grains, the grains were sterilized at -18 ºC for 48 hours to eradicate any visible and concealed insect and mite infestations. To equilibrium the moisture content of these grains, they were conditioned for at least a week in an incubator at 35±1 **°C** and 60±5% R.H. These grains were used to mass raise the insect in glass jars with a capacity of 2 liters. The insects used for the infestation were collected from the Agricultural Research Center in Sakha, Kafr El-Sheikh. The adults that emerged were used in the experiments.

effect of host grains on the biological aspects.

The lesser grain borer *R. dominica* biological experiments were conducted in the laboratory at a constant temperature degree of 35 ± 1ºC, and 60 ± 5 % relative humidity (R.H.) on each host grain Wheat *(Triticum aestivum)* , Maize (*Zea mays*), Rice (*Oryza sativa*), and Oat (*Avena sativa*) under Completely Randomized Design (CRD). Observations were made on progeny, weight loss,

* **Corresponding author.**
E-mail address: monamoatamed@mans.edu.eg
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developmental time for the first and second generation of the insect. Five pairs of unsexed adults, 2-3 weeks old, were placed on 10 gm of each type of grain used in the study and removed 7 days after egg-laying in grains. Following that, host- grain samples containing *R. dominica* eggs were preserved under 35 ±1 ºC and 65 ± 5 % RH to evaluate the emergence of F1 progeny. Per each evaluation day, emerging progeny till 30 days and considered as the first generation, the grains were then weighted to determine the amount of weight loss. and after 60 days from the initial infestation individuals were counted on each dish to evaluate the second-generation progeny and the weight loss also. (Bashir, 2002).

The susceptibility index was estimated using method of (Dobie,1974):

$$y = \frac{\text{Natural Log}(F)}{D} x\ 100,$$

Where:

F is the number of first-generation progeny.

D is the median development period for *R.dominica*.

Chemical composition of investigated grain cultivars (Wheat, Rice, Maize and Oat).

- Determination of Moisture Content: According to (Marwaha, 2010).
- Determination of Ash Content; Crude Fiber and Crude Protein: According to (McCleary *et al.*,20**13**).
- Determination of Total carbohydrates: According to (William, 2000).
- Determination of minerals: According to (Peters *et al.*, 2009and Kumpulainen *et al.*, 1983).

Statistical analysis

Data for all experiments were analyzed One-way ANOVA by Costat Version 6.45 (CoHort Software) (Stern ,1991).

RESULTS AND DISCUSSION

Effect of Different Host Grains on The Biological Aspects of *R. dominica* at 35±1ºC:

The obtained results arranged in Table (1) showed that the effect of different host grains on the developmental period for the lesser grain borer *R. dominica* from egg until the emergence of the adult, the average number of the first and the second generations F1 and F2 and the weight loss produced by the insect on both generations as well as the susceptibility index of the tested grains to *R. dominica*.

It can be noticed that the shortest developmental stages period recorded when insect reared on wheat grains followed by rice grains and represented by 25.4 ± 0.75 and 26 ± 0.68 days, respectively. While the longest developmental period was recorded when reared on maize grains (27.0 ± 0.40 days).

Moreover, the highest average number for the first generation (F1) were recorded when reared on wheat grains followed by oat grains and presented by 46.8 ± 0.74 and 42.60 ± 0.52 individuals, respectively. The highest average number of progeny of the second generation (F2) also recorded on wheat grains followed by oat grains and presented by 76.2 ± 4.27 and 67.2 ± 2.52 individuals, respectively. The lowest progeny for F1 and F2 were recorded on maize grains and presented by 23.2 ± 1.43 and 39.40 ±2.99 individuals, respectively (Table 1).

While oat during the first generations lost more weight, which represented by: (0.65 ± 0.02 g) and the least weight loss for the first generation was on maize (0.40 ± 0.02g) during the second generation the highest weight loss was on rice followed by wheat and represented by, 1.08 ± 0.08 and 1.01 ± 0.08 g, respectively. while the least weight loss for the second generation was on maize which represented by 0.74 ± 0.02g. The susceptibility index where was the highest on wheat grains followed by oat grains which represented by 15.19 ± 0.39 and 14.34 ± 0.40, respectively. Meanwhile, the lowest susceptibility index was recorded on maize grains and presented by 11.62 ± 0.30 (Table 1).

The results of statistical analysis indicated that a significantly differences in developmental, F1and F2 progeny and susceptibility index according to the different host grains at 35±1ºC for rearing the insect pest, while were no significant differences on weight loss for F1 between oat, rice and wheat, maize, while on weight loss of F2 there were no significant differences on wheat, maize, and rice grains.

Several authors (Breese, 1960; Golebiowska, 1969; Rao and Wilbur, 1972 and Campbell and Sinha, 1976;) assessed the grain loss consumed by the lesser grain borer *R. dominica* in the laboratory, and there were differences in weight loss between authors, which could be due to different experimental conditions or the hardness of grains or strains of *R. dominica*. According to (Kumar, 2017 and Nayak and Daglish, 2018) the susceptibility index varied between different host- grains and it agrees with the research findings.The development period on wheat grain was the shortest 25.40 days these result in agreement with (Birch, 1953 and Edde, 2012).(Perez-Mendoza *et al*., 1999) indicated that *R. dominica* reared on rice or wheat were more active than those reared on Maize what explain that the weight loss was the least on Maize grains.

Table 1. Effect of Different Host Grains on The Biological Aspects of The Lesser Grain Borer *R. dominica* at 35±1ºC.

Host Grains Biological aspects	Wheat	Maize	Rice	Oats
Developmental period	25.40 ± 0.75a	27.0 ± 0.40a	26 ± 0.68a	26.20 ± 0.52a
F1 progeny	46.80 ± 0.73a	23.2 ± 1.43d	32.0 ± 1.05c	42.60 ± 0.52b
F2 Progeny	76.20 ± 4.27a	39.40 ±2.99c	49.20 ±2.22b	67.2 ± 2.52a
F1 Weight loss	0.49 ± 0.04b	0.40 ± 0.02b	0.62 ± 0.05a	0.65 ± 0.02a
F2 Weight loss	1.01 ± 0.08a	0.74 ± 0.02a	1.08 ± 0.08a	1.00 ± 0.03b
susceptibility index	15.19 ± 0.39a	11.62 ± 0.30c	13.05 ± 0.29b	14.34 ± 0.40a

Mean ± SE followed by the different letters in a row are significantly differences at 5% level of probability (Duncan's Multiple Rang Test). (n=5, df=3).

The obtained present data illustrated in Fig. (1) cleared that the weight loss percentage of host grains resulting to feeding *R. dominica* during the two generations F1 and F2 according to the different temperature degrees. The highest weight loss percentage for F1 and F2 were recorded on rice (6.16 and 10.76%) followed by oat (10.14 and 4.88%) for the two generations, respectively. Meanwhile, the lowest weight loss for F1 and F2 recorded on maize and presented by 7.40

and 4.02%, respectively. Statistical analysis indicated that, there was no significant differences temperature in the weight loss percentage on wheat, rice, and oat grains for F1.

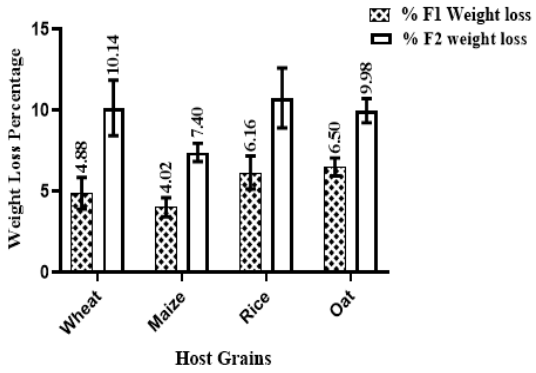

Fig (1): Weight loss percentage of different host grains at 35±1°C

Data arranged in Table (2) showed the chemical composition of four host-grains of Poaceae family (Wheat, Maize, Rice, and Oat), and a group of chemical components and elements were estimated. It can be noticed that Wheat was the shortest developmental period and the highest progeny in the two generations and the highest susceptibility index where the highest percentage of protein (11.03%) on the other hand wheat was the lowest on fibers (0.76%), and fats 1.20%). Also, low percentage of ash (0.90 %), magnesium (1.02 mg.100g^{-1}), zinc (1.69 mg.100g^{-1}), and iron (0.83 mg.100g^{-1}) while oat was the highest on weight loss and highest percentage of fats (7.13%) in addition to moisture (13.13%) also was the highest content of those elements' potassium (349.61mg.100g^{-1}), phosphorus (476.96 mg.100g^{-1}), magnesium (112.93mg.100g^{-1}) and calcium (53.19mg.100g^{-1}).

Table 2. Chemical Composition of Different Poaceae Grains.

	Wheat	Maize	Rice	OAT
Protein%	11.03	10.16	8.30	10.54
Total Carbohydrate%	74.49	71.16	78.21	64.47
Fat%	1.20	3.51	1.46	7.13
Moisture%	11.62	10.58	9.80	13.13
Fibers%	0.76	2.67	1.35	3.17
Ash%	0.90	1.93	0.87	1.56
Elements (mg.100g^{-1})				
K	129.41	269.76	166.72	349.61
P	144.05	281.03	139.06	476.96
Phenol	93.86	170.46	18.15	87.08
Mg	1.02	45.97	76.46	112.93
Ca	22.79	22.37	17.14	53.19
Zn	1.69	5.87	5.06	11.76
Fe	0.83	3.25	3.47	3.53
Oil		3.96		

While Maize was the most resistant host grain with the lowest susceptibility index and longest developmental period, it was noticed that Maize contains the highest amount of phenol (170.46 mg.100g^{-1}) and oil (3.96 mg.100g^{-1}).

According to results all cereal grains are highly preferred by *R. dominica*. Furthermore, wheat is the most preferred host grain when compared to other cereals. Progeny can be influenced by various types of cereal grains, which are influenced by the quality of grains. The quality can be measured by chemical properties, these have an impact on the development of insects. The suitable nutritional content in cereals can increase the progeny of *R. dominica* (Arthur *et al*., 2012 and Toews *et al*. (2001) mentioned that the chemical structure of grains can strongly influence the progeny of *R. dominica*. the chemical characteristics of grains are one of the most effective factors affecting the development of *R. dominica* (Astuti *et al*.,2013).

The percentage 12-14% of moisture of grain is the optimum temperature for *R. dominica* development is between at 26 -34 ºC (Birch, 1945 and Edde, 2012). And this result agrees with the research results.

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تأثير الحبوب المختلفة العائلة على الخصائص البيولوجية لثاقبة الحبوب الصغرى *Rhyzopertha dominica* (Fab.) (Bostrichidae: Coleoptera).

سمير صالح عوض الله ، هالة أحمد كامل الصيرفي ، عبد البديع عبد الحميد غانم و منى معتمد علي شلبي

قسم الحشرات الاقتصادية – كلية الزراعة – جامعة المنصورة.

الملخص

أجريت التجارب بمعمل الحشرات التابع لقسم الحشرات الاقتصادية بكلية الزراعة جامعة المنصورة. استخدمت التجربة اختبار عدم الاختيار لتقييم بعض الجوانب البيولوجية لحشرة ثاقبة الحبوب الصغرى على حبوب مضيفة مختلفة وباستخدام اختبار ANOVA الإحصائي أحادي الاتجاه لفهم ما إذا كانت الاختلافات معنوية أو غير معنوية بناءً على الحبوب المضيفة، ثم تم إجراء تحليل كيميائي. تم إجراؤه لفحص المكون الكيميائي الأكثر فعالية في قابلية ثاقبة الحبوب الصغرى أظهرت النتائج أن ثاقبة الحبوب الصغرى التي تم تربيتها على حبوب القمح كان له أقصر فترة نمو (25.40 ± 0.75 يوم) وأعلى ذرية للجيل الأول والثاني (46.80 ± 0.73 و76.20 ± 4.27 للأفراد) وكان القمح هو أكثر الحبوب المضيفة حساسية بمؤشر حساسية (15.19 ± 0.39). كما تؤثر النسبة المئوية للبروتين والألياف والدهون والرماد ومحتوى الحبوب من المغنيسيوم والزنك والحديد على الجوانب البيولوجية لحشرة ثاقبة الحبوب الصغرى أشارت النتائج إلى وجود علاقة بين الخصائص البيولوجية وقدرة الحشرة على إحداث الضرر ونوع حبة العائل بالإضافة إلى تركيبها الكيميائي.