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Response of *Sitophilus zeamais* (Coleoptera: Curculionidae) to different volatiles of wheat grains

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Abstract

The wheat volatile study has a great potential to increase the efficiency and attractiveness of the baits for managing insects populations. In addition, the identification of volatile or biological active compoubds allow to modify the insect behavior, having great practical interest due to its potential and its usage for development of integrated systems for managing pests. The study aimed to verify the *Sitophilus zeamais* attractiveness to different wheat varieties and verify *S. zeamais* reception potential to the extract of the most attractive variety. In the extracts preparation it was used 10 g of the varieties Rubi, Ônix, BRS 179, BRS 194, BRS Angico, BRS Camboatá and BRS Canela that were triturated and placed put in a small glass container and topped with solvent (hexan). It was used adults of *S.zeamais* non sexed, from 7 to 14 days old, raised at 25 °C and 65 % of r.h. The *S. zeamais* behavior was analyzed through olfactometre in"Y" shape. Each olfactometre lower arm received a 5 cm diameter filter folded and full of wheat volatile of each variety of wheat and other with the control (solvent hexan). Twenty insects were released on the bigger arm of the olfactometre, observing at the 5, 10 e 15 minutes in 3 repetitions the behavior of the insects. After observing the insects behavior in relation to each variety extract, it was done a variance analysis and a Tukey test. There was significant difference between the wheat varieties. The Rubi and BRS Angico varieties presented the highest attractiveness for the insects. To at 15 minutes, 43,5 % e 42 % of the insects were at the olfactometre arm which had the treatment with Rubi and BRS Angico extract, respectively. The analysis through as chromatography of these varieties can result an attractive active fraction for the *S. zeamais*, important for future studies.

Key words: insect behavior; volatiles of grains; olfactometre; *S. zeamais.*

Introduction

The storage of cereals is greatly necessary due to the following reasons we face nowadays: the high production levels, the need to forecast the provision for its usage throughout the year, the need to prevent possible periods of shortage, to provide a better stability of prices and to preserve the physical-chemical and nutritive aspects of the cereals. Moreover, the importance of the storage lies in the fact that the adequate storage of agricultural products reduces losses, preserves the quality, gives a better return to the farmer and benefits to the consumer (Jayas et al., 1995).

It is important to point out that even under good storage conditions, frequent losses occur. The main agents that cause losses of stored products are the microorganisms, insects, acari,

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rodents and birds (Faroni, 1998; Lazzari, 1997). Under tropical conditions, insects have a particular importance as a kind of stored grains pest, because of the fact that the mass of grains is the ideal environment for its development.

The infestation of the mass of grains by the insects may propitiate the fungous development and modify the physical environment (temperature and humidity level) of the grains, promoting their deterioration, as well as the alteration of the nutritional balance (levels of protein, carbohydrate and lipid). The successive generations of insects shall amplify these damages, causing economical losses or even the impossibility of the commercialization of the product (Robert et al., 1991)

The Integrated Pest Management program has looked forward to develop natural measures in the handling and control of pests, like biopesticides, the choice of more resistant to insect attacks varieties of grains, genetic improvement and other practices to substitute the techniques and products conventionally used.

With the continuous pressure from the food industry and from the consumers for the reduction in the use of insecticides, the development of monitoring techniques and pest control which cause little environmental impact and which do not leave any residues in the products is extremely important.

The chemical ecology has played an important role in the development and synthesis of pheromones of the main agricultural pests in Brazil for more effective and safe control programs. For some species of insects which attack stored grains, the pheromones have already been identified, synthesized and are being used in traps in silos and warehouses for the control of these species. With the advances in the study of the chemical ecology of the insects many questions have aroused regarding the interaction of the pheromone and the volatile of the insect's host plant or its food.

Several authors have studied the role of the chemical stimulus of feeding plants in the attractiveness of insects for the alimentation and reproduction. Konstantopoulou et al. (2002), analyzed the attractiveness/ repellence of extracts of eight hybrids of corn in the laying of *Sesamia nonagrioides* (Lepidoptera: Noctuidae) and found that extracts obtained with different solvents interfered in the selection for the laying of the female. Extracts with pentane solvent stimulated the laying, while extracts with methanol solvent stopped or repelled the females to lay.

Examples of the association between sexual and alimentary attractiveness include the coleopterans of grains *Sitophilus oryzae* (Coleoptera: Curculionidae), *Tribolium castaneum* (Coleoptera: Tenebrionidae) and *Rhyzopertha dominica* (Coleoptera: Bostrichidae) (Cox, 2004). In these species, the pheromone was liberated only when the males were feeding on the grains, and there was no liberation of pheromones when the food was removed.

Hammack et al. (2001) concluded that the mixture of volatile of corn and the sexual synthesized pheromone of *Diabrotica* spp. (Coleoptera: Chrysomelidae) caused a synergist effect, having a great potential to improve the efficacy and attractiveness of traps for the management of insect populations.

According to Germinara et al. (2002), the identification of volatile or compounds biologically active allows us to change the behavior of the insects, having a great practical interest due to its potential use and for the development of integrated systems for the handling of pests.

In experimental observations from Pinto Jr. and Ceruti (2005), analyzing the answer of the *Sitophilus zeamais* (Coleoptera: Curculionidae) to different volatile of corn grains, a greater attractiveness for specific hybrids of the culture, obtaining more expressive results when hexan solvent was used.

The olfactometry consists of the detection and characterization of odors in environments, and an applied use of it exists for the study of the attraction of insects, with several models of olfactometry machinery adapted for these studies. The olfactometry in "Y", developed by Barrows in 1907, is a specific model for insects of small

size (Vilela and Della Lucia, 2001).

The objective of this study is to evaluate the answer of *S. zeamais* to volatile compounds extracted from different varieties of wheat grains (*Triticum* spp.), verifying the reception potential of the pest to the extract of each variety.

Material and methods

For this experiment, non sexed adults of *S. zeamais* were used, 7 to 14 days old, created at 25 ºC and 65 % of relative humidity from individuals collected from the Grain Storage Unit at the Pontifícia Universidade Católica do Paraná – PUCPR.

The varieties of wheat selected for the study were: Rubi and Ônix from OR Melhoramento de Sementes Ltda and BRS 179, BRS 194, BRS Angico, BRS Camboatá and BRS Canela from Embrapa Trigo, and the solvents used were ether and hexan, adding 14 treatments, with 3 repetitions per treatment. The extracts were prepared grinding 20 g of grains of each variety in a grinding machine, separating each 10 g in small glass containers, previously sterilized, with lid. Each triturated variety was put in two different containers, in one of those ether solvent was added and hexan solvent in the other, and a week period was allowed for them to rest.

The biotests for the verification of activity of *S. zeamais* before the volatile emitted by the varieties of wheat were performed by olfactometry, with an olfactometer in "Y" (Figure 1) which consists of a glass tube in "Y" (with a longer arm and two shorter ones in the forked extremity) which operates horizontally and the air flow is produced by vacuum suction from the shorter arms towards the longer one. Each shorter arm received a paper filter impregnated with the volatile of each variety and the other only with the control (ether or hexan solvent). For each treatment, 20 insects were released in the longer arm of the olfactometer, and the answer to the olfactory stimulus were observed, 5, 10 and 15 minutes after the liberation, in 3 repetitions. After each period of time notes about the position of the insects inside the set were taken, that is only in the tube, present in the right arm (only with the solvent) or in the left arm (solvent with the extract from the corn hybrid). In this way it was possible to determine the number of insects which moved to each arm of the olfactometer.

After the insects behavior to the extracts of each variety was observed, the data were submitted to the analysis of variance for the verification of attractiveness, with a later comparison between means by the Tukey Test ($p<0,05$) obtained from each of the solvents used (ether or hexan).

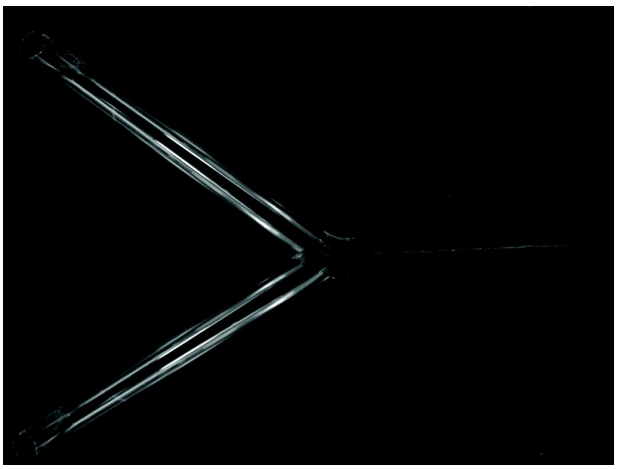

Figure 1. Olfactometer em "Y".

Results and Discussion

Among the solvents used for the preparation of the extracts of the wheat varieties, hexan presented the best results for the attractiveness of insects. There was a significant difference between the wheat varieties. The extracts from the varieties Rubi and BRS Angico were the most attractive for *S. zeamais*, since there is no statistical difference between them, followed by the variety BRS Camboatá. After 15 minutes of observation 43,5 % and 42 % of the insects were in the arm of the olfactometer which contained the variety Rubi and BRS Angico respectively. Regarding the BRS Camboatá variety, after 15 minutes 37 % of the insects migrated to the arm of the olfactometer which contained the extract. The extracts of the variety BRS 194 and BRS

Canela were the least attractive ones when compared to the results of the biotests with the hexan solvent. In the biotests performed with the extracts prepared with the ether solvent there was no statistical difference between the attraction results within the seven varieties in study (Table 1).

Table 1. Average number of *S. zeamais* attracted after 15 minutes by extracts of the varieties prepared with hexan solvent and ether, in 3 repetitions.

	Means	
Extract	Hexan	Ether
Rubi	6.6 a	4.7 a
Ônix	4.0 cd	4.4 a
BRS179	4.9 bc	4.2 a
BRS194	3.3 d	3.5 a
BRSAngico	6.4 a	3.7 a
BRSCamboatá	6.0 ab	3.3 a
BRSCanela	2.8 d	3.5 a

* Means followed by the same letter in the columns do not differ in between by the Tukey Test, at a 5 % probability.

In preliminary tests from the authors, the answer of the insects to volatile compounds extracted from different corn hybrids was observed, and a more attractive hybrid and less attractive one for the same species of insect could be detected.

The grain volatile can induce the production or liberation of pheromones in certain insects and frequently synergize or amplify the answers of insects to the sexual pheromones. These compounds can also have an inhibitory or repellent effect, interrupting the insects answer to their own pheromone (Reddy and Guerrero, 2004).

The identification of volatile or biologically active compounds has a great practical interest due to its potential use and for the development of integrated systems for the handling of pests for stored products (Germinara et al., 2002). There are few studies about the subject, mainly for pests of stored grains, having presented this study, data which will allow an evaluation on the more attractive and repelling varieties, the purity of the active fraction of the hybrid extract, might result in the discovery of a potentially active substance to the tested pest.

The results found in this project may be used for the research of a potentially active fraction to the *S. zeamais*, contributing in the future to integrated pest management programs in a safer and more reliable way.

Conclusion

Based on the results and on the conditions for the carrying out of the experiment it is possible to conclude that the most attractive varieties for the *S. zeamais* were Rubi and BRS Angico, with the results being significant only when the biotests were performed with the hexan solvent. The varieties BRS 194 and BRS Canela were less attractive to the pest, with the same solvent.

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