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Damage Caused by *Tribolium castaneum* (Coleoptera: Tenebrionidae) in Stored Brazil nut

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Abstract. *Tribolium castaneum* is an insect that occurs worldwide and it is a pest that attacks stored products, in particular, grains and seeds. The adult and immature forms are categorized as secondary pests which feed on grains or seeds previously damage in storage conditions. The objective of this study was to describe the type of damage caused by adults and immature of *T. castaneum* in Brazil nuts and identify the type of damage caused by Coleoptera. It was also verified whether the shell can protect the almond from the attack of this pest. The lesions inflicted by this insect starts as a scratched surface, which evolves into galleries and even injuries capable of modifying the original shape of the almond. Due to its capacity to promote considerable damage with consequent losses in the value of the nuts, *T. castaneum* may be listed among pests of Brazil nut categorized as primary pest by its ability to initiate injuries in the intact almond.
Keywords: Adults and immatures, tunnels, new categorization, primary pest.

Introduction

The genus *Tribolium* includes pests commonly found in storage facilities of grains and seeds and they cause substantial losses in products like cereals, brans, animal's food, flours and others (Trematerra & Sciarretta, 2004; Daglish, 2006).

The species *Tribolium castaneum* and *Tribolium confusum* (Coleoptera: Tenebrionidae) are the most commonly representatives of this genus found in Brazil. Morphologically, they have great similarities, and the separation is basically done by the differences in their antennae and head structures. The last three antennal segments in *T. castaneum* are distinctly wider and the lateral edge of the head extends to 1/3 of the distance of the eye when laterally observed. On the other hand, *T. confusum* does not have such pronounced last three antennal segments and the lateral edge of the head extends to 2/3 of the distance of the eye in the lateral view (Pereira & Almeida, 2001).

Tribolium castaneum is popularly known as the beetle of the flour and it is considered a cosmopolitan insect, mainly prevalent in the tropics (Rees, 1996; Faroni & Sousa, 2006). This beetle is categorized as a secondary pest because the adult and immature forms feed on pre-cracked or broken grains, which were damaged by primary pests; however, reports in the literature describe the ability of this insect to survive even in the undamaged grains (White, 1982).

Brazil nut, compared with other products used in human food, has not stood out in the international scientific literature. It may be partly explained due to the regions of its production, restricted mainly to the Amazon Biome (Thomas et al., 2015). However, despite of being produced only in certain areas of South America, its consumption is observed across all the continents (ITC, 2015), and it is an important income source for innumerable families that live by extractive activities (Homma, 2012; Moll-Rocek et al., 2014). The greatest scientific efforts related to Brazil nuts are studied from the perspective of this product as an influence on human health (Gonzales and Salas. 2006; Berno et al., 2010; Colpo et al., 2013).

There are even efforts to understand the relationship of these nuts with the aflatoxigenic fungi (Arrus et al., 2005; Pacheco et al., 2010; Martins et al., 2012). Studies conducted to comprehend the behavior of the *Bertholletia excelsa* seeds during the pre-processing and industrialization steps are still incipient (Ribeiro et al., 1993; Nogueira et al., 2014; Kluczovski et al., 2015), however, such types of research have emerged due to the current demand for export of a product that fits the laws of importing countries (Álvares et al., 2012).

The efforts of these researchers are raising people involved in the Brazil nut chain awareness, from the forest to the market, and attempt to promote better storage conditions for this product. Storage facilities are being built with the intention of promoting a rapid removal of this product from the forest and its proper storage until processing.

Among several problems related to storage of agricultural products, the pests of stored grains are responsible for huge losses in rice, corn, soybean, sorghum, and others (Martins et al., 1985; Santos et al., 2002; Caneppele et al., 2003; Silva et al. 2003; Alves et al. 2008; Faroni & Silva, 2008; Alencar et al., 2011). Few species have been reported attacking stored Brazil nut, among them, the larvae of *Plodia interpunctella* (Lepidoptera: Pyralidae) were observed damaging this product causing galleries damage in almonds (Gomes et al., 2015).

Another report was the occurrence of larvae of Curculionidae in chestnuts, damaging the bast and promoting the appearance of grooves in the mesocarp (Castrillón & Purchio, 1988), however, this search does not specify the type(s) of species found, nor refers that the attack occurs in the almond, since the mesocarp of Brazil nut is constituting part of the chestnut and not of the nut. “Broca-do-café” beetle, *Hypothenemus hampei* (Coleoptera: Scolytidae) was reported attacking the almond of *Bertholletia excels* (Gumier-Costa, 2009). There is also the report of association of *Tribolium confusum* and *Tribolium ferrugineum* in warehouses of Brazil nut, which in this work is referred as Pará nut, but without characterizing or describing the attack and possible damage (Bondar, 1942). It is also reported on the Technical Bulletin of the North Agronomic Institute that *T. castaneum* attacks Pará nut (Sefer, 1961), however, there are no reports of damage characterization, it is only mentioned that this species may be considered a little harmful to this Amazon product.

The objective of this study was to describe the type of damage caused by adults and immature of *T. castaneum* in Brazil nuts and verify whether the shell protects the almonds from attack by this pest.

Methods

This work was carried out in the Laboratory of Energy and Pests of Stored Grains (LEPGA) of the Federal University of Mato Grosso, Campus of Sinop, in Sinop, State of Mato Grosso, Brazil. Intact unshelled almonds of the Brazil nut (almonds with fully brown skin) were offered to *Tribolium castaneum* (adults and immature forms) in order to assess damage. Two experiments were performed. In the experiment 1 - only the adults of this Coleoptera were used, and in the experiment 2, newly hatched larvae.

In the experiment 1, damage caused by *T. castaneum* adults were assessed in 24-hour periods, for 30 days and 90 days of exposure. Groups of 10 individuals were put in covered plastics pots of 250 ml volume (9.5 cm in diameter and 7.5 cm in height), in a total of 20 repetitions for each evaluation period.

Figure 1. Damages in the shell of the Brazil nut under study with respect to the penetration capacity of *Tribolium castaneum* (Coleoptera: Tenebrionidae).

In the experiment 2, damage caused by the newly hatched larvae in Brazil nut was evaluated after 24 hours after exposure and in the end of the larval stage evidenced by the emergence of the pupae. Almonds exposed to the adults and immature forms were visually evaluated using a stereoscopic microscope to enable the characterization and description of damage caused by this insect.

Some aspects related to *T. castaneum* penetration into shelled Brazil nut were also investigated. To perform this bioassay, 60 shelled Brazil nuts were used. From this total, the shells of 30 almonds had been pre-damaged (cracked) using a hammer (Figs. 1 A-D), while the other 30 almonds shells remained intact. Each almond was placed in a plastic pot of 200 ml volume and 10 adults of *T. castaneum* were introduced. After 30 days, the almonds were removed, opened and checked the occurrence of the pest attack.

Results

Both adult and immature forms of *T. castaneum* were able to feed on intact Brazil nuts. After 24 hours of exposure of intact unshelled Brazil nuts to the *T. castaneum* adults, spall was observed, accompanied by fine nut powder on the almond surfaces. The first signs of damage caused by adults are the lesions in the form of scratched surface, it was

observed under the stereoscopic microscope (Fig. 2 A and B). The greatest damage was observed in the nuts exposed to the adults of *T. castaneum* for 30 days. This damage evolved into galleries on the almond surface (Fig. 2 C and D). Large lesions were observed in the almonds after exposure to *T. castaneum* for 90 days. These lesions evolved from the galleries to the fully injured portions, which nuts can be distinguishable by changing the original shape (Fig. 2 E and F).

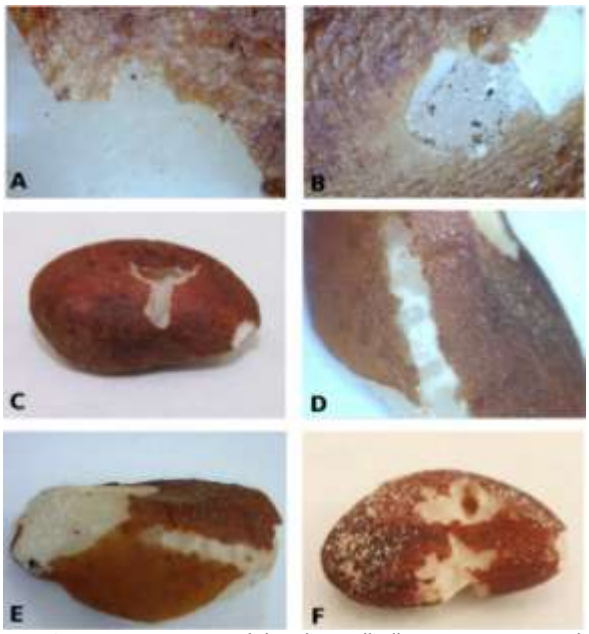

Figure 2. Damages caused by the *Tribolium castaneum* adults (Coleoptera: Tenebrionidae) in the intact Brazil nuts after 24 hours (A and B), 30 days (C and D) and 90 days (E and F) of exposure.

Considering the ability of the *T. castaneum* to penetrate into the intact shelled Brazil nut and access the interior of the almonds, it was confirmed that the beetles lack this capacity. On the other hand, this pest attacked the almonds with cracked shells (Fig. 3 A and B).

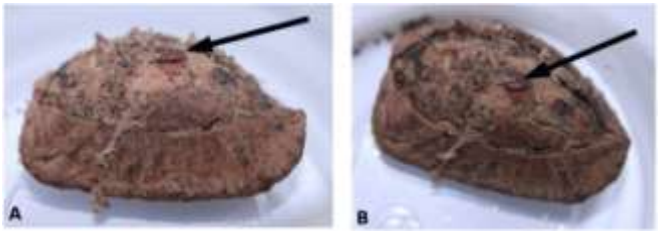

Figure 3. *Tribolium castaneum* (Coleoptera: Tenebrionidae) inside a Brazil nut with a cracked shell, after 30 days of infestation.

Discussion

The capacity of the adult and immature forms of *Tribolium castaneum* to feed on intact unshelled Brazil nut may be explained by the lower degree of resistance of the Brazil nut surface to penetration by this insect's chewing mouthparts, when compared to the resistance of the surfaces of grains or seeds like corn, rice, soybean and others. Thus, *T. castaneum* may be classified as a primary pest for Brazil nut.

Damage caused by adults and immature in almonds of *Bertholletia excelsa* distinguish this insect as a builder of galleries which may evolve into larger lesions. Based on the type of destruction caused by *T. castaneum* in Brazil nut, this insect may be classified, for this product, as a pest capable of generating quantitative and qualitative damage. In the first one, the attack of *T. castaneum* caused evident loss of dry matter resulting in losses of bulk, mass, concurring with problems associated with pest attack in other stored grains (Venkatrao et al., 1958; Caneppele et al., 2003). In the second one, the damage may affect seed germination, depreciating the almond and causing nutritional losses, which are the main features of the pest attack in stored products.

The access of the pest to the interior of the Brazil nut is only via cracks in the shell. Besides they were manually made in this study, cracks may occur in the post-harvest and processing steps of this product, especially due to the thermal processes, like drying, for instance. Thus, any type of injury in the shell that allows the insect passage into the interior of the nut will be the only way for the insect to access the almond. However, whether the shell is intact, it prevents the access and attack by the pest due to the resistance and protection that it offers to the almond.

Thus, it may be concluded, from this work, that *T. castaneum* must be included in the list of pests that attack and have great potential to inflict significant losses in the stored Brazil nut, and may even be considered the primary pest for this product. The damage observed as shallow scrapings, which may develop into galleries and even lesions that modify the original shape of the nut. Finally, the intact shell of Brazil nut ensures the integrity of the almonds, in the event of attack by the beetle *T. castaneum*.

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References

ALENCAR, ER., FARONI, LRA., FERREIRA, LG., COSTA, AR., PIMENTEL, MAG. Qualidade de milho armazenado e infestado por *Sitophilus zeamais* e *Tribolium castaneum*. Engenharia na Agricultura 19(1): 9-18, 2011.

ÁLVARES, VS., CASTRO, IM., COSTA, DA., LIMA, AC., MADRUGA, ALS. Qualidade da castanha-do-

brasil do comércio de Rio Branco, Acre. Acta Amazônica 42:269-274, 2012.

ALVES, WM., FARONI, LRA., ALENCAR, ER., PAES, JL. Influência do inseto-praga *Sitophilus zeamais* (Motschulsky) (Coleoptera: Curculionidae) na taxa respiratória e na perda de matéria seca durante o armazenamento de milho. Engenharia na Agricultura 16:260-269, 2008.

ARRUS, K., BLANK, G., ABRAMSON, D., CLEAR, R., HOLLEY, RA. Aflatoxin production by *Aspergillus flavus* in Brazil nuts. Journal of Stored Products Research 41:513-527, 2005..

BERNO, LI., POETA, PT., MARÓSTICA-JUNIOR, MR. Effects of selenium derived Pie Brazil-nut on the concentration of reduced glutathione (GSH) in Wistar rats. Feeding Nutrition. 21:231-239, 2010..

BONDAR, G. Alguns coleopteros nocivos aos productos vegetaes armazenados na Bahia. Nota Entomológica Bahia X. Revista de Entomologia 13:226-229, 1942.

CANEPPELE, MAB., CANEPPELE, C., LÁZZARI, FA., LÁZZARI, SMN. Correlation between the infestation level of *Sitophilus zeamais* Motschulsky, 1855 (Coleoptera, Curculionidae) and the quality factors of stored corn, *Zea mays* L. (Poaceae). Revista Brasileira de Entomologia 47:625-630, 2003.

CASTRILLÓN, AL., PURCHIO, A. Fungos contaminantes ε produtores de aflatoxinas em castanha do pará (*Bertholletia* excelsa HUMB. & BONPL 1808). Acta Amazônica 18:173-183, 1988.

COLPO, E., VILANOVA, CDA., REETZ, LGB., DUARTE, MMMF., FARIAS, ILG., MULLER, EI., MULLER, ALH., FLORES, EMM., WAGNER, R., ROCHA, JBT. A single consumption of high amounts of the Brazil nuts improves lipid profile of healthy volunteers. Journal of Nutrition and Metabolism 1-7, 2013.

DAGLISH, GJ. Survival and reproduction of *Tribolium castaneum* (Herbst), *Rhyzopertha dominica* (F.) and *Sitophilus oryzae* (L.) following periods of starvation. Journal of Stored Products Research 42: 328-338, 2006.

FARONI, LRA., SILVA, JS. Manejo de pragas no ecossistema de grãos armazenados. In: SILVA, J.S. (ed) Secagem e armazenagem de produtos agrícolas. Editora Aprenda Fácil, 2nd. Viçosa, BR. p. 371-406, 2008.

FARONI, LRA., SOUSA, AH. Aspectos biológicos e taxonômicos dos principais insetos-praga de produtos armazenados. In: Almeida, FAC., Duarte, MEM., Mata, MERMC. Tecnologia de Armazenagem em sementes, UFCG, Campina Grande, BR. p. 371-402, 2006.

GALLO, D., NAKANO, O., CARVALHO, RPL., BAPTISTA, GC., BERTI FILHO, E., PARRA, JRP., ZUCCHI, R.A., ALVES, SB., VENDRAMIM, JD., MARCHINI, LC., LOPES, JRS., OMOTO, C. Manual de entomologia agrícola. Piracicaba, BR, vol.10, 920 p. 2002.

GOMES, FB., KRUG, C., TAVARES, JG. First record of the indian meal moth, *Plodia interpunctella* (Hubner, 1813) (Lepidoptera: Pyralidae) for brazil nut. Bioscience Journal 31:1708-1710, 2015.

GONZÁLEZ CA., SALAS, S. The potential of nuts in the prevention of cancer. British Journal of Nutrition 96:87-94, 2006.

GUMIER-COSTA, F. First record of the coffee berry borer, *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae), in Pará nut, *Bertholletia excelsa* (Lecythidaceae). Neotropical Entomology 38: 430-431, 2009.

HOMMA, AKO. Extrativismo vegetal ou plantio: qual a opção para a Amazônia? Estudos Avançados, 26: 167-186, 2012.

ITC. International Trade Center. Trade Map: Trade statistics for international business development. 2016. http://www.trademap.org/(X(1)S(0qdidm455pq2wcbrcsbmjw55))/Country_SelProduct_TS.aspx?nvpm=1

KLUCZKOVSKI, AM., MARTINS, M., MUNDIM, SM., SIMOES, RH., NASCIMENTO, KS., MARINHO, HA. KLUCZKOVSKI JUNIOR, A. Properties of Brazil nuts: A review. African Journal Biotechnology 14: 642-648, 2015.

MARTINS, DS., FARONI, LRA., SILVA, FAP., SOUZA, FF. Avaliação das perdas antes da colheita e no armazenamento do milho, pelo gorgulho *Sitophilus* sp. e pela traça *Sitotroga cerealella* na microrregião de Viçosa. Revista Brasileira de Armazenamento 10:6-8, 1985.

MARTINS, M., PACHECO, AM., LUCAS, ACS., ANDRELLO, AC., APPOLONI, CR., XAVIER, JJM. Brazil nuts: determination of natural elements and aflatoxin. Acta Amazônica 42:157-164, 2012.

MOLL-ROCEK, J., GILBERT, ME. BROADBENT, EN. Brazil nut (*Bertholletia excelsa*, Lecythidaceae) regeneration in logging gaps in the Peruvian Amazon. International Journal of Forestry Research 1-8, 2014.

NOGUEIRA, RM., ÁLVARES, VS., RUFFATO, S., LOPES, RP., SILVA, JS. Physical properties of Brazil nuts. Engenharia Agrícola 34: 963-971, 2014.

PACHECO, AM., LUCAS, A., PARENTE, R., PACHECO, N. Association between aflatoxin and aflatoxigenic fungi in Brazil nut (*Bertholletia excelsa* H.B.K.). Ciência Tecnologia de Alimentos 30: 330-334, 2010.

PEREIRA, PRVS., ALMEIDA, LM. Chaves para identificação dos principais Coleoptera (Insecta) associados com produtos armazenados. Revista Brasileira Zoologia 18: 271-283, 2001.

REES, DP. Coleoptera. In: Subramanyam, B., Hagstrum, DW. Integrated management of insects in stored products. Marcel Dekker, New York, USA. p. 1-39,1996.

RIBEIRO, MAA., REGITANO-D'ARCE, MAB., LIMA, UA., BAGGIO, CE. Armazenamento da castanha do pará com e sem casca: efeito da temperatura na resistência ao ranço. Scientia Agrícola 50:343-348, 1993.

SANTOS, AK., FARONI, LRA., GUEDES, RNC., SANTOS, JP., AFONSO, ADL. Nível de dano econômico de *Sitophilus zeamais* (M.) em trigo armazenado. Revista Brasileira de Engenharia Agrícola e Ambiental 6:273-279, 2002.

SEFER, E. Boletim Técnico, nº 43. Boletim Técnico do Instituto Agronômico do Norte, 1961.

SILVA, AAL., FARONI, LRA., GUEDES, RNC., MARTINS, JH., PIMENTEL, MAG. Modelagem das perdas causadas por *Sitophilus zeamais* e *Rhyzopertha dominica* em trigo armazenado. Revista Brasileira de Engenharia Agrícola e Ambiental 7:292-296, 2003.

THOMAS, E., ALCÁZAR CAICEDO, C., MCMICHAEL, CH., CORVERA, R., LOO, J. Uncovering spatial patterns in the natural and human history of Brazil nut (*Bertholletia excelsa*) across the Amazon Basin. Journal of Biogeography 42:1367-1382, 2015.

TREMATERRA, P., SCIARRETTA, A. Spatial distribution of some beetles infesting a feed mill with spatio-temporal dynamics of *Oryzaephilus surinamensis*, *Tribolium castaneum* and *Tribolium confusum*. Journal of Stored Products Research 40:363-377, 2004.

VENKATRAO, S., NUGGEHALLI, RN., SWAMINATHAN, M., PINGALE, SV., SUBRAHMANYAN, V. Effect of insect infestation on stored grain. III. - Studies on kaffir corn (*Sorghum vulgare*). Journal of the Science of Food and Agriculture 9:837-839, 1958.

WHITE, GG. The effect of grain damage on development in wheat of *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). Journal of Stored Products Research 18: 115-119, 1982.