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Bioprospection of plant extracts from the Caatinga for the control of *Spodoptera frugiperda* (J.E. Smith, 1797) (Lepidoptera: Noctuidae)

Bioprospecção de extratos vegetais da Caatinga para o controle da Spodoptera frugiperda (J.E. Smith, 1797) (Lepidoptera: Noctuidae)

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N O T E

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A B S T R A C T

The objective was to evaluate the insecticidal effect of extracts of *Ziziphus joazeiro* Mart., *Croton sonderianus* and *Amburana cearenses* on the hatchability of eggs of the fall armyworm *Spodoptera frugiperda* J. E. Smith (Lepidoptera: Noctuidae). The extracts of the three plant species were produced at concentrations of 5%, 10% and 15%, and distilled water as a control. For each concentration, paper towel discs containing 30 eggs were immersed for 30 seconds and then left to dry, being placed in plastic pots. Each treatment consisted of four replicates containing 30 eggs each. After 24 hours of exposure to the extracts, daily readings were taken for eight days, considering that eggs not hatched after this period were not viable. During the analysis of the ovicidal effect of plant extracts on the embryonic development of *S. frugiperda* eggs, the hatching rate and efficiency rate of the extracts were verified. We can conclude that the hydroalcoholic extracts of *C. sonderianus*, *Z. joazeiro* and *A. cearenses* were efficient in inhibiting the hatchability of *S. frugiperda* larvae at doses of 10 and 15% of the plant structures, proving that the extracts of these plant species can be used in the reduced hatchability of eggs.

Palavras-chave:
Bioinseticida
Manejo Integrado
Inibição de eclodibilidade

R E S U M O

O objetivo foi avaliar o efeito inseticida dos extratos do *Ziziphus joazeiro* Mart., *Croton sonderianus* e *Amburana cearenses* sobre a eclodibilidade dos ovos da lagarta do cartucho *Spodoptera frugiperda* (J.E. Smith, 1797) (Lepidoptera: Noctuidae). Os extratos das três espécies vegetais foram produzidos nas concentrações de 5%, 10% e 15%, e a água destilada como testemunha. Para cada concentração, discos de papel toalha contendo 30 ovos foram imersos por 30 segundos e, em seguida, postos para secar, sendo acondicionados em potes plásticos. Cada tratamento foi composto de quatro repetições contendo 30 ovos cada. Após 24 horas de exposição aos extratos, foram realizadas leituras diárias por oito dias, considerando inviáveis ovos não eclodidos após este período. Durante a análise do efeito ovicida de extratos vegetais sobre o desenvolvimento embrionário de ovos de *S. frugiperda,* foi verificada a taxa de eclosão e taxa de eficiência dos extratos. Podemos concluir que os extratos hidroalcoólicos do *C. sonderianus*, *Z. joazeiro* e *A. cearenses* foram eficientes na inibição de eclodibilidade das larvas de *S. frugiperda* nas doses de 10 e 15% das estruturas vegetais, comprovando que os extratos dessas espécies vegetais podem ser utilizados na redução da eclodibilidade dos ovos.

INTRODUCTION

The corn *Zea mays* L. (Poaceae) is among the most cultivated and consumed cereals in the world, due to its productive potential, chemical composition and nutritional value, having multiple applications that begin with human and animal feeding, still driving a large complex industrial (POLATO; OLIVEIRA, 2011).

In the management of corn, many problems are observed, which may be related to the precarious income situation of the farmers, the low availability of capital for agriculture, the low level of technology adopted and the incidence of pests, which attack the crop in practically all phases of its cycle, causing quantitative and qualitative losses (CAMPOS; BOIÇA JUNIOR, 2012).

The fall armyworm, *Spodoptera frugiperda* (J.E. Smith, 1797) (Lepidoptera: Noctuidae) is considered one of the most important pests of the Americas and the main pest of corn in Brazil (CRUZ, 2000; CASMUZ et al., 2010; MURÚA et al., 2015). *S. frugiperda* can attack the corn crop from seedling emergence to ear formation, its presence in the initial stages of the crop can cause high grain losses and productivity, due to the sensitivity of plants, which do not resist damage. caused by the plague (CRUZ et al., 2013).

The control of the fall armyworm has been carried out predominantly with chemical products, records in the Ministry of Agriculture, Livestock and Supply have 257 products registered for corn cultivation (AGROFIT, 2022).

The constant use of pesticides without rotation of molecules and observations of the integrated management of pests, has been triggering a series of problems, among them, residues in food, elimination of natural enemies, intoxication of applicators, consumers and the environment, emergence of populations of resistant insect pests, as well as mutagens, carcinogens and teratogenics (PEREIRA et al., 2017; ROCHA; GRISOLIA, 2019).

Several researches have been carried out aiming at the insertion of less toxic, more selective molecules that present reduced environmental danger, with the identification of plants and chemical compounds that can cause biological, behavioral and physiological effects on agricultural pests (ROEL et al., 2000; FIGUEIREDO et al., 2006; SOUZA et al., 2017).

Plant defenses are physical and chemical, secondary or allelochemical compounds (nitrogen compounds, terpenoids and phenolics) are substances produced by individuals of one species that influence biology, behavior, health and, as a consequence, the reduction of the other species (WHITTAKER; FEENY, 1971; BALDIN et al., 2019). Therefore, it is important to study and identify plant species that can cause adverse effects on insect pests, expanding the options for integrated pest management in different cropping systems.

The native species of the Caatinga: *Ziziphus joazeiro* Mart. (Rhamnaceae), *Croton sonderianus* (Euphorbiaceae) and *Amburana cearensis* (Fabaceae), have similar importance and uses, such as forage potential, medicinal properties and beekeeping, being plants very attractive to pollinators. *Z. joazeiro* has been used for economic purposes, in the manufacture of shampoos, cosmetics and toothpaste, as well as firewood in the production of charcoal (MARINHO et al., 2002; LORENZI; MATOS, 2008; DANTAS et al., 2014).

C. sonderianus is very efficient for forest restoration in soil recovery and erosion protection (LEAL et al., 2003; MAIA-SILVA et al., 2012). *A. cearenses* is widely used in woodworking and in the manufacture of sweets, cigarettes, tobacco, soaps, soaps and perfume fixatives. Another use is in the manufacture of barrels for the aging of beverages (PAREYN et al., 2018).

Thus, the objective of this work was to evaluate the ovicidal effect of extracts of *Z. joazeiro*, *C. sonderianus* and *A. cearenses* on the hatchability of eggs of the fall armyworm *S. frugiperda* J. E. Smith (Lepidoptera: Noctuidae).

MATERIAL AND METHODS

The experiment was conducted at the Plant Health Laboratory of the Federal Institute of Education, Science and Technology of Alagoas – IFAL, Campus Piranhas. It is located at coordinates 9° 37' 20.83" S and 37° 45' 83" W, at an altitude of 181 m.

Insect breeding

The stock colony of *S. frugiperda* was initially constituted of larvae collected in corn crops in the California irrigated perimeter, Canindé de São Francisco – Sergipe.

Adult couples were individualized in 22 x 23 cm plastic buckets, lined internally with newsprint and closed with "filo" or "tulle" fabric, with elastic at the edges. The moths were fed with a 10% honey solution and vitamin C supplied by capillarity through pieces of cotton, renewed every two days. The eggs, removed from the oviposition substrate, were counted and kept in containers with moistened paper until the larvae hatched.

The caterpillars were then individualized in plastic containers (5.0 x 5.0 cm), to avoid cannibalism among themselves, containing an artificial diet according to Kasten Junior et al. (1978), remaining until the pupal stage. And after the emergence of adults, they were transferred to the plastic buckets.

Diet preparation

The diet was prepared according to the methodology proposed by Kasten Junior et al. (1978), the beans were initially cooked for 30 minutes, eliminating excess water after cooking, and then the beans were ground in a blender for 180 seconds with agar and 500 mL of distilled water. Then, putting them on low heat, after boiling, stir for three minutes.

In sequence, ascorbic acid ($C_6H_8O_6$), sorbic acid ($C_6H_8O_2$), formalin, wheat germ, brewer's yeast, methylparaben, inhibitor solution and 500 mL of distilled water were added to the bean mixture, which was mixed in a blender for three minutes.

The diet was then placed in an aluminum tray, previously sterilized and stored in a refrigerator, with a maximum shelf life of 10 days.

Collection of plants and obtaining extracts

Plant structures (branches and leaves) of *Z. joazeiro*, *C. sonderianus* and *A. cearensis* were collected in the municipalities of Piranhas-AL and Canindé de São Francisco-SE. After collection, they were taken to the laboratory, where they were cleaned in running water for complete elimination of impurities and placed to dry at room temperature, where they remained for 24 hours. After these procedures, the materials were separated by species, placed in paper bags and dried in an oven at a temperature of 40 °C for 48 hours, and the branches were kept for up to 96 hours. R-TE-650, Tecnal® brand until powder is obtained, and then stored in dry and hermetically sealed jars.

For the preparation of the extracts, the vegetable powder was added to the ethyl alcohol in the proportion of 1:100, that is, 01 gram of vegetable powder for 100 mL of alcohol of each treatment. Then, the samples were centrifuged in a laboratory centrifuge, routine model 380R, brand Hettich, at 3,000 rpm for 10 minutes and kept at rest for 24 h in a refrigerated system to extract the water-soluble compounds.

After this period, the material was filtered through a "voil" type cloth to remove the solid material, and again subjected to agitation to volatilize the solvent, then filtered and the volume completed with distilled water, obtaining a hydroalcoholic solution at the desired concentration according to the methodology proposed by Vendramim et al. (2000).

Ovicidal test

The ovicidal effect of plant extracts was evaluated from the concentrations: 5.0%, 10.0% and 15.0% and distilled water as a control. For each concentration, paper towel discs containing 30 eggs were immersed for 30 seconds and then set to dry, being placed in plastic pots. Each treatment consisted of 4 replicates containing 30 eggs each. After 24 hours of exposure to the extracts, daily readings were taken for 7 days, considering that eggs not hatched after this period were not viable.

The data were submitted to analysis of variance (ANOVA) and the means of the treatments were compared using the Tukey test ($P \leq 0.05$) at 5% probability through the computer application SISVAR (FERREIRA, 2011).

RESULTS AND DISCUSSION

Ovicidal activity

During the analysis of the ovicidal effect of plant extracts on the embryonic development of *S. frugiperda* eggs, the hatching rate and efficiency rate of the extracts were verified (Table 1).

Table 1. Number of eggs *S. frugiperda* hatched after treatment with plant extracts at different concentrations.

Plant species	Concentration of extracts			
	0%	5%	10%	15%
A. cearensis	26.0 a	14.2 a	1.0 a	0.0 a
Z. joazeiro	27.5 a	16.0 a	10.2 b	1.2 a
C. sonderianus	28.2 a	23.0 b	3.5 a	0.0 a

*Mean followed by the same letter in the column do not differ by Tukey test at 1% probability.

According to table 1, the hatchability data in the control, there was no significant difference, highlighting the high hatchability, as they are subjected to ideal conditions of temperature and humidity and absence of any contamination. However, in the concentration of extracts at 5%, there was a significant difference between them, the *C. sonderianus* extract at this concentration resulted in greater hatchability in relation to the other analyzed bioproducts, while the A. cearensis and the *Z. joazeiro* did not differ from each other. However, in the concentration of extracts at 10%, the least viable extract was that of *Z. joazeiro*, on the other hand, there was no significant difference between the extracts of *A. cearensis* and *C. sonderianus*. In the 15% concentration of plant bioextracts, the greatest action occurred in reducing the hatchability of eggs, with no significant difference between plant species.

Other studies corroborate the action of secondary metabolites in the development of insects, Oliveira et al. (2020) obtained promising results with applications of essential oils from *C. sonderianus* bark, in the extension of the pupal period of the leaf miner *Liriomyza sativae* Blanchard, 1938 (Diptera: Agromyzidae), in addition to causing a reduction in oviposition and feeding punctures in confinement tests.

Research developed with extract of cotyledons of *A. cearenses*, showed that in the concentration of 0.8%, there was a reduction in larval mass of *Callosobruchus maculatus* (Fabricius, 1775) (Coleoptera: Chrysomelidae) more than 66%, and from 1.6% onwards, causes 100% larval mortality (OLIVEIRA, 2017).

Studies with *Ceratitis capitata* (Wiedmann, 1824) (Diptera: Tephritidae) showed that the ingestion of a diet with *Z. joazeiro* extract by the larvae resulted in a mortality of 99.0%. The toxicity of *Z. joazeiro* to *C. capitata* larvae was observed when its leaves were collected in the senescence phase (SILVA et al., 2015). While the tests with the pupa of *C. capitata*, with the *Z. joazeiro* extract, no mortality was obtained with the concentrations evaluated (0.5%; 1.0%; 5.0% and 10.0%). However, the extracts influenced the development time of the pupal phase, observing adverse effects with the 10% *Z. joazeiro* extract (SANTOS, 2019). According to table 2, we verified the efficiency of the bioextracts in the concentrations used to reduce the hatching of *S. frugiperda* eggs.

Table 2. Efficiency of plant species studied at different concentrations for the control of *S. frugiperda* eggs.

Plant species	Extract concentrations			
	0%	5%	10%	15%
A. cearensis	13.33%	52.5%	96.67%	86.67%
Z. joazeiro	8.14%	46.67%	65.84%	87.70%
C. sonderianus	5.84%	23.33%	88.34%	94.16%

According to table 2, the lowest percentage efficiency of the test with the bioactive compounds was obtained with the quince plant extract at a concentration of 5%, however, satisfactory results were achieved when using the concentration of 15%, with efficiency in reducing hatchability above of 86%.

The use of the plant bioextracts studied, due to their ovicidal action, associated with monitoring techniques with delta-type sex pheromone traps, favors the monitoring of the arrival of the *S. frugiperda* moth to the crop, serving as a warning for taking action to control at an appropriate time, before the eggs hatch. These integrated measures make it possible to reduce the number of pesticide applications, toxicological damage to the applicator, environment and production costs.

CONCLUSION

The hydroalcoholic extracts of *C. sonderianus*, *Z. joazeiro*, *A. cearensis* were efficient in inhibiting the hatchability of *S.frugiperda* larvae with favorable results at concentrations of 10 and 15% of the biocompounds.

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