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Toxicity of oil from *Anacardium humile* **Saint Hill (Anacardiaceae), on** *Bemisia tuberculata* **(Bondar, 1923) (Hemipttera: Aleyrodidae) on cassava plants**

Toxicidade do óleo de *Anacardium humile* Saint Hill (Anacardiaceae) em *Bemisia tuberculata* (Bondar, 1923) (Hemiptera: Aleyrodidae) em plantas de mandioca

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RESUMO: Objetivou-se avaliar o efeito tóxico do óleo essencial de *Anacardium humile*, em diferentes concentrações, na sobrevivência e desenvolvimento da mosca branca *Bemisia tuberculata*, principal praga da cultura de mandioca, *Mahihot esculenta* Crantz. O experimento foi conduzido em casa-de-vegetação em temperatura de 26±4ºC. Vinte indivíduos adultos foram confinados em gaiolas, que encerrava uma folha de mandioca e retirados após 24 horas. O óleo foi pulverizado nas concentrações de 0,006%; 0,05%; 0,8% e 2,0%, quando as ninfas estavam fixas nas folhas. Os dados foram coletados diariamente com a contagem de ninfas, pupas e adultos e nas datas em que ocorreram as passagens de cada fase. Todos os tratamentos aumentaram a duração da fase jovem. A mortalidade decresceu com a concentração do óleo na fase de ninfa, respectivamente, 79,81% (2%), 77,89% (0,8%), 79,98% (0,05%) e 67,14% (0,006%). A mortalidade total de pseudopupas seguiu o mesmo padrão em relação à concentração do óleo essencial. O óleo essencial das folhas de *A. humile* é fornecedor de molécula(s) inseticida(s) e causam efeitos deletérios em *B. tuberculata* com aumento da duração da fase jovem, mortalidade de ninfas e do total de pseudopupas.

PALAVRAS-CHAVE: Plantas inseticidas, sesquiterpenos, controle de pragas da mandioca, mosca branca.

ABSTRACT: The aim was to evaluate the toxic effects of essential oil of Anacardium humile, in different concentrations, on survival and development of the whitefly *Bemisia tuberculata* on the cassava plants, *Manihot esculenta* Crantz. The experiment was carried out in a greenhouse at a temperature of 26±4º C. Twenty adults were confined in cages, which contained a leaf of cassava plant and removed after 24 hours. The oil was sprayed in the concentrations of the 0.006%, 0.05%, 0.8% and 2%, when the nymphs were attached to the leaves. Data was collected daily by counting nymphs, pseudopupae and adults and the passages of each stage. All treatments increased the juvenile phase. The mortality in the nymphal stage decreased with the oil concentration, respectively, 79.81 (2%), 77.89 (0.8%), 79.98 (0.05%) and 67.14% (0.006%). The total mortality of pseudopupae followed the same tendency. The essential oil from the leaves of *A. humile* is a supplier of molecule(s) insecticide(s) and causes a deleterious effect on *B. tuberculata* with increased of the the juvenile phase, nymphal and total mortality of pseudopupae.

KEY WORDS: Pesticide plants, sesquiterpenes, cassava pests control, whitefly.

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Introduction

One of the main problems with the cassava crop, *Manihot esculenta* Crantz, in the state of Mato Grosso do Sul is the presence of the whitefly *Bemisia tuberculata* Bondar (1923) (Aleyrodidae) (LIMA et al., 2001). Direct damage is caused to plants by the whitefly, because they suck continuously on the sap. This insect can transmit viral diseases causing damage to the point of possibly destroying the plant. They are also carriers of the herbivorous mite. They excrete a sugary substance called "honeydew" allowing the fungus *Capnodium* sp. that causes sooty mold on the leaf with reduction of the photosynthesis.

Farmers sprayed the plants with chemical control to combat the whitefly, *B. tabaci*, which is a pest that attacks other crops. These products often cause environmental and toxicological problems. Viegas Jr. (2003) added that many insects had developed a resistance mechanism to the synthetic chemicals.

An alternative to minimize these effects is the use of insecticides from plants to the pest control agents because the population is reduced by various deleterious effects (MARTINEZ & VAN EMDEN, 1999). This bioactive compound can cause repellence, the feeding and the oviposition deterrence, biocides activity, growth inhibitors, inhibitors of the formation of chitin and reproductive suppression (CAVALCANTE et al., 2006). According to Passinati et al. (2009), the oil from neem *Azadirachta indica* is efficient to control whitefly nymphs in cabbage. These active ingredients have a potential to be a safe alternative to the chemical pesticides, because promote less selection pressure that causes the evolution of the resistance in the insect population (SOUZA et al., 2008).

The *Anacardium humile* St. Hill (Anacardiaceae), known as 'cajuzinho-do-cerrado', has a social significance in Brazilian Cerrado and the Pantanal wetlands. The leaf oil was reported to have insecticidal potential for larvae of *Aedes aegypti* (PORTO et al., 2008). Its aqueous extract caused mortality of nymphs of whitefly *Bemisia tuberculata* and the elongation of the nymph phase, according to Andrade Filho et al. (2010). The aim was to determine the efficiency of volatile oil from leaves of *A. humile* on whitefly development in cassava plants.

Material and Methods

Oil isolation: Leaves of *Anacardium humile* were collected in October 2007 in a Cerrado in Campo Grande, MS, Brazil (20º26'20.64''S; 54º32'26.78''O). This specie was identified by Me. Eloty J. D. Schleder and a voucher specimen (RG 5558) was deposited at the Herbarium of the Universidade Anhanguera, Uniderp, Campo Grande, MS, Brazil. The essential oil was obtained by separate hydro distillation using a Clevenger-type apparatus for four hours. At the end of each distillation the oils were collected, dried with anhydrous Na_2SO_4, measured, and transferred to glass flasks that were filled to the top and kept at a temperature of −18°C for further analysis. The sample was analyzed by GC-MS and GC-FID (WINCK et al., 2010).

Biological activity: the experiments were conducted in a greenhouse, with the temperature adjusted to 26±4°C, from December 2007 to September 2008.

Cages of white voile, contained only a cassava leaf from plants two months old, closed by *velcro* on the base of the stem. In each cage, 20 adult insects, male and female were kept, for a period of 24 hours, for copulation and egg laying. After this period, these cages were removed. So, each leaf with eggs represented a repetition. Ten leaves with eggs were sprayed only with distilled water for the control.

In a closed cage there were five plants per treatment. Ten samples were taken from each treatment with two leaves per plant. Formulations were prepared with essential oil from leaves of *A.*

humile diluted in distilled water at the following concentrations: 2.0, 0.8, 0.4, 0.05 and 0.006%, based on previous experiments. These were sprayed with a manual sprayer on the leaves that had nymphs of *B. tuberculata*. The spraying was done on the thirteenth day, when most of the nymphs (of first instars) were already attached to the leaves. The spraying was done at dusk, to avoid light and heat, which could accelerate the degradation of active components. In the last nymph stage it is considered pseudo-pupae.

Monitoring the action of products was performed daily by counting of the number of nymphs surviving until adult emergence, through a magnifying glass (30X).

The data analysis was by the ANOVA performed using the SANEST program. The means were compared using the Tukey test ($P<0.05$), and the results were expressed as the mean ± standard error of the mean (± SEM).

Results and Discussion

The oil yield from the fresh leaves of the *A. humile* plant was 0.1%. Thirty-five oil compounds were identified in the leaves, 85.7% were sesquiterpenes and 14.3% monoterpenes. The major constituents in the oil leaves were α-bulnesene (8.6%), γ-cadinene (7.5%), selina-3.7(11)-diene (6.7%), α-himachalene (6.1%) and cyperene (5.0%), (E)-β-E-ocimene (3.3%), γ-terpinene (2,9%), 1,7-di-epi-β-cedrene (2.5%), 7-epi-α-selinene (2.4%), α-neoclovene (2.2%), γ-curcumene (2.1%), γ-muroleno (1.8%), β-selinene (1.8%), δ-cadinene (1.7%) e ciclosativene (1.2%) (WINCK et al., 2010).

In this work, the essential oil from leaves of *A. humile* in all concentrations caused an increase in the juvenile stage of B. tuberculata, compared to the control development (Table 1). However, the nymphs duration did not differ between concentrations of the essential oil, but increased in relation to the control (Table 1).

Table 1: Duration of immature of whitefly *B. tuberculata* (Bondar, 1923) (Aleyrodidae) (± SEM) after treatment with essential oil of *A. humile* Saint Hill (Anacardiaceae) in different concentrations, in green-house, T 26 ± 4 °C.

Treatment (%)	Duration of immature (days) ± SEM*
2	5,73 ± 2,29 b
0.8	23,16 ± 2,52 b
0.4	23,84± 2,61 b
0.05	24,02 ± 1,07 b
0.006	22,23 ± 1,36 b
Control	13,58 ± 0,86 a
C.V. (%)	19,43

*SEM = Standard error of the mean.
Means followed by distinct letters in the same column differ in the Tukey test ($P<0.05$).

The lengthening of the juvenile phase is considered to be one of the deleterious effects of some plant products on the insects with action on the physiology. Many researchers attribute the fagoinhibitory effect and growth inhibitor to many species of insects, for sesquiterpenes. In the work that was carried out it was detected that this group is the major constituent in the essential oil from the leaves of the *A. humile* plant.

Researchers found one of the effects of the use of the insecticide plants is the lengthening of the life cycle of the insects (ROEL & VENDRAMIM, 2006; MARTINEZ & VAN EMDEN, 1999). According to Mordue & Nisbet (2000) the deleterious physiological effects can also be measured through reduced growth and the appearance of abnormalities.

The treatments also reduced the number of nymphs of *B. tuberculata* significantly with all concentrations compared to natural mortality observed in control (Table 2). Albergaria et al. (2003) reported in the life table of the whitefly *B. tabaci* in soybean mortality of 14,82% only in the 1º instar. Souza & Vendramim (2001) also reported mortality of the nymph stage of *B. tabaci* between 7.4 and 19%, when ground in tomato plants. Although, a tendency to decrease mortality with concentration was observed, respectively, 79.81% (2%) 77.89% (0.8%) 79.98% (0.05%) and 67.14% (0.006%) (Table 2). Total mortality on the pseudopupae stage, in all treatments, was observed. Out of 2 415 nymphs that received treatments, only 20.99% (507) reached the pseudopupae stage. However, all of them died without reaching full development.

These promising results demonstrated the insecticide ability of the essential oil of this plant. This effect was also obtained by Porto et al. (2008) when tested the activity of the same oil against the larvae of *A. aegypti*. The researchers described

Table 2: Effect of essential oil from leaves of *A. humile* Saint Hill (Anacardiaceae) in different concentrations on mortality (± SEM) of nymphs *B. tuberculata* (Bondar, 1923) (Aleyrodidae) in a green house, T 26 ± 4°C.

Concentration (%)	Mortality (%) (± SEM*)		
	Nymph	PseudoPupae	Total
2	79,81 ± 15,35 b	100 ± 0,00 a	100 ± 0,00 a
0,8	77,89 ± 9,72 b	100± 0,00 a	100± 0,00 a
0,4	91,46± 1,92 b	100± 0,00 a	100± 0,00 a
0,05	79,98 ± 7,70 b	100± 0,00 a	100± 0,00 a
0,006	67,14 ± 23,45 b	100± 0,00 a	100± 0,00 a
Control	18,01 ± 11,16 a	14.81± 3,43 b	32.02± 4,64 b
C.V. (%)	19.27	2.20	6.80

*SEM = Standard error of the mean.
Means followed by distinct letters in the same column differ in the Tukey test (P<0.05).

these as being highly toxic, causing 100% mortality of the larvae at concentrations up to 0.125%. The presence of sesquiterpenes indicates great possibilities of toxicity (BROCHINI et al., 1999) and it has a variety of biological activities which cause interference in the metamorphosis of the insect (MATIAS et al., 2003). According to Viegas Jr. (2003) sesquiterpenes cause in insects inhibitors and retards growth, reduce reproduction capacity and appetite, may cause acute toxicity effect and become easy targets for predators. Lima et al. (2006) explains that between volatile composites, the sesquiterpenes are known as fagoinhibitor and inhibitors of growth in many insect species. Similarly in this present research the retardation of development and mortality in the young phase was observed.

Conclusion

The oil from the *A. humile* leaf, rich in sesquiterpenes, causes a deleterious effect on *B. tuberculata* leading to increased mortality of nymphs and total mortality of the pseudopupae stage.

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