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ALTERNATIVE CONTROL OF THE TOMATO RED MITE (*Tetranychus evansi* BAKER and PRITCARD, 1960) (ACARI: TETRANYCHIDAE)

Mércia Elias Duarte[1,2] Márcia Daniela dos Santos[3] & Edmilson Santos Silva[4]

[1,2] Embrapa Recursos Genéticos e Biotecnologia; PqEB, Asa Norte, Cx. Postal 02372, CEP 70.770-917, Brasilia, DF, Brazil. E-mail: mercia_elias@hotmail.com
[3] Depatamento de Ciências Biológicas - Universidade do Estado de Mato Grosso, Campus de Alta Floresta - UNEMAT, Rod. MT-208, KM 147, Jardim tropical, Cx,. Postal 324, CEP 78580-000 - Alta Floresta, MT, Brasil. E-mail: md_santos2006@hotmail.com
[4] Universidade Federal de Alagoas, Campus Arapiraca, Arapiraca, Alagoas 57309-005, Brazil. E-mail: silva_es@yahoo.com.br
[2*] **Corresponding author:** Mércia Elias Duarte (mercia_elias@hotmail.com).

ABSTRACT: The *Tetranychus evansi* Baker and Pritchard (Acari: Tetranychidae) mite is one of the major tomato pests and can cause significant production losses. This study aimed to evaluate the toxicity of alternative products to control the *T. evansi* mite in different development stages. Neem (*Azadirachta indica* A. Juss.), "mastruz" (*Dysphania ambrosioides* (L.) Mosyakin & Clemants), garlic (*Allium sativum* L.), manipueira extracts and cow urine were used at concentration of 5% and Azamax® (100%) and control (water only). Tomato leaflets were immersed in the respective extracts for five seconds, time enough for the solution to contact the leaf surface. Then, each leaflet received 15 immature mites (larvae and nymphs) and fifteen adult females. The experiment consisted of seven treatments for immature and adult stages, each with four replicates in randomized blocks. The results showed that for immature forms, Azamax® caused 65.8% mortality rate, garlic extract 53.3%, "mastruz" extract 48.3%, neem extract and cow urine 46.7%, "manipueira" 23.3% and in control (water only) mortality rate was 6.7%. In tests with adult females, the treatment with the highest mortality rate was Azamax®, which presented 38.3%, followed by garlic extract with 18.3%, "mastruz" extract with 15%, cow urine with 11.7%, neem and "manipueira" extracts with 6.7% and control with 3%.

KEYWORDS: *Solanum lycopersicum*, phytophagous mites, insecticide plants, *Allium sativum*, *Azadirachta indica.*

CONTROLE ALTERNATIVO DO ÁCARO-VERMELHO-DO-TOMATEIRO (*Tetranychus evansi* BAKER e PRITCHARD, 1960) (ACARI: TETRANYCHIDAE)

RESUMO: O ácaro *Tetranychus evansi* Baker e Pritchard (Acari: Tetranychidae) é uma das principais pragas do tomateiro e pode causar prejuízos significativos à produção. Objetivou-se avaliar a toxicidade de produtos alternativos no controle do ácaro *T. evansi* em diferentes fases de desenvolvimento. Foram utilizados, extratos de nim (*Azadirachta indica* A. Juss.), mastruz (*Dysphania ambrosioides* (L.) Mosyakin & Clemants), alho (*Allium sativum* L.), manipueira e urina de vaca, na concentração de 5% e Azamax® (100%) e a testemunha (apenas água). Os folíolos de tomateiro foram imersos nos respectivos extratos, durante cinco segundos, período suficiente para a solução entrar em contato com a superfície foliar. Em seguida, cada folíolo recebeu 15 ácaros imaturos (larvas e ninfas) e quinze fêmeas adultas. O experimento foi constituído por sete tratamentos para as formas imaturas e adultas, cada um com quatro repetições em blocos inteiramente casualizados. Os resultados demonstraram que para as formas imaturas o Azamax® causou mortalidade em 65,8%, o extrato de alho 53,3%, o extrato de mastruz 48,3%, o extrato de nim e urina de vaca 46,7%, a manipueira 23,3% e na testemunha (apenas água) a mortalidade foi de 6,7%. Nos ensaios com fêmeas adultas o tratamento com maior índice de mortalidade foi Azamax® que apresentou 38,3%, seguidos dos extratos de alho com 18,3%, do extrato de mastruz com 15%, da urina de vaca 11,7%, do extrato nim e da manipueira com 6,7% e a testemunha 3%.

PALAVRAS CHAVE: *Solanum lycopersicum*, ácaros fitófagos, plantas inseticidas, *Allium sativum*, *Azadirachta indica.*

INTRODUCTION

Tomato, *Solanum lycopersicum* L. (Solanaceae), is considered one of the most important vegetables in the agricultural sector, since it contributes to the trade of fresh products and extracts. Tomatoes are among the most consumed fruit vegetables in the world (FAO, 2019). Currently, Brazil occupies the ninth position with 2.5% of world production, with annual cultivated area of approximately 64.4 thousand hectares (IBGE, 2018).

Tomato production has faced serious problems due to the increasingly occurrence of pests and diseases that make crop management difficult (Pratissoli and Carvalho, 2015). Among these, some mite species, such as the broad mite - *Polyphagotarsonemus latus* (Banks, 1904) (Acari: Tarsonemidae), the tomato russet mite - *Aculops lycopersici* (Tryon, 1917) (Acari: Eriophyidae), the two-spotted spider mite - *Tetranychus urticae* (Koch, 1836) and the red tomato mite - *T. evansi* Baker and Pritchard, 1960 (Acari: Tetranychidae), are considered important pests for the tomato crop and attack several other Solanaceae species, which can lead to substantial production losses. In addition, they are of difficult management (Moraes and Flechtmann, 2008). As a result, there is an intensive and indiscriminate use of various chemical products. According to information from the Program for the Analysis of Pesticides Residues in Food of the National Health Surveillance Agency (ANVISA, 2012), through the analysis of about 2,500 food samples in 2018, 32.6% of tomato samples had pesticide concentrations above allowed levels.

T. evansi is a pest, until then, considered specific to plants of the Solanaceae family, to which tomato belongs (Moraes and Flechtmann, 2008). These mites cover leaves with a large amount of web, making it difficult for predators to act, which provides rapid population growth (Sabelis and Bakker, 1992). Tomato leaves attacked by *T. evansi* turn yellowish to whitish and fall prematurely, leaving fruits exposed to the sun, which, in turn, do not acquire the characteristic red color, depreciating the product (Moraes and Flechtmann, 2008).

The control of the tomato red mite has been done, in most cases, with the use of synthetic acaricides. Despite the easy acquisition and use, problems such as the development of mite resistance (Nicastro et al., 2010; Van Leeuwen et al., 2010; Hoy, 2011), change in the behavior of natural enemies (Delpuech et al., 1999; Van Leeuwen et al., 2010; Hoy, 2011), high toxicity of products and lack of compliance with grace periods, in addition to environmental problems, are often associated with the exclusive use of chemical control in tomatoes.

The availability of methods alternative to chemical control is a need not only for producers, but also for consumers who demand products free of pesticide residues, produced with environmentally safe technology (Medeiros et al., 2007; Moraes & Flechtmann, 2008; Van Leeuwen et al.; 2010 Hoy, 2011). For this reason, measures that enable reducing the application of these products in crops must be implemented.

The use of plant extracts with insecticidal activity represents an important alternative for pest control in small cultivation areas such as vegetable gardens, a situation in which the production of extracts becomes viable (Dequech, 2008). Such methods are favorable, since they are easy to use, have low cost and do not harm the environment. In addition, they can be produced by producers on their own properties (Mazzonetto and Vendramim, 2003). The bioactive substances present in natural products extracted from plants are shown to be compatible for use in Integrated Pest Management (IPM) programs (Medeiros et al., 2005; Thuller et al., 2008; Zotti et al., 2010). Thus, the aim of this study was to evaluate the toxicity of the following alternative products: neem extract (*Azadirachta indica* A. Juss.), garlic extract (*Allium sativum* L.), mastruz extract (*Dysphania ambrosioides* (L.) Mosyakin & Clemants), manipueira, from *Manihot esculenta* Crantz, cow urine and Azamax®) in the control of tomato red spider mite (*T. evansi*) at different development stages.

MATERIAL AND METHODS

The experiment was carried out at the Laboratory of Entomology/Acarology of the Federal University of Alagoas (UFAL) - Campus of Arapiraca. All assays were performed at 25 ± 2 ºC, RH 75 ± 10 % and 12-hour photophase.

T. evansi was collected from tomato plants in an experimental area in the aforementioned Campus and maintained on tomato leaves, which were placed on a metal screen suspended by two 500 mL plastic pots inside a 3-L PVC container. To maintain the turgidity of leaves for a longer period, the terminal part of branches was wrapped with cotton and left in direct contact with water at the bottom of the container.

The vegetables used to elaborate the extracts came from a property in the municipality of Teotônio

Vilela - Alagoas. Neem leaves (*A. indica*), mastruz leaves (*D. ambrosioides*) and garlic bulbs (*A. sativum*) were used. Initially, the material was dried in a forced aeration oven at 45 °C for 48 hours. Then, they were crushed separately in a blender and stored in hermetically sealed containers.

To elaborate extracts, 50 g of powder of each plant species were used per liter of alcohol, corresponding to concentration of 5%. These mixtures were kept for 24 hours in closed containers, after which they were strained separately and stored.

To obtain manipueira, approximately 1 kg of grated and pressed cassava (*M. esculenta*) was used. Cow urine was obtained at the milking time, on the same property mentioned above. Both cassava and cow urine were kept in closed containers and used 24 hours after collection. For tests with these products, 50 ml were used for each liter of water, corresponding to concentration of 5%.

In addition to natural products, Azamax®, a product based on *A. indica*, was used in an emulsifiable concentrate formulation containing 12 g/L of azadirachtin (1.2% w/w). This product was used at concentration of 3 mL/L of water, that is, at 100% of the recommended dosage for *T. uticae* (Agrofit, 2011).

Tests were carried out with immature forms and adult females of the pest mite. Initially, leaflets were inspected under stereoscopic microscope to verify the absence of immature or adult forms, mites or insects. Subsequently, each leaflet was sanitized with running water and placed on paper towels at room temperature of approximately 25 °C to dry for 30 minutes. Then, leaflets were immersed in extracts for five seconds, time enough for the solution to come into contact with the leaf surface.

All treated leaflets were dried at room temperature on paper towels for 30 minutes to eliminate excess liquid. To maintain turgidity during the analysis of experiments, leaflets had their petioles wrapped with cotton and moistened with distilled water. Subsequently, 15 immature mites (larvae and/or nymphs) or adult females from breeding maintained in laboratory for approximately two generations were transferred to leaflets treated with the aid of a fine-bristled brush under stereoscopic microscope with magnification of up to 40x. Subsequently, leaflets were superimposed on filter paper in plastic containers with capacity of 145 mL and 6.5 cm in diameter, which were covered with PVC plastic film to prevent mites from escaping.

Evaluations took place every 24 hours for 5 days, using stereoscopic microscope with 40x magnification. The death of mites was confirmed when the individuals presented immobility after being touched with a fine-bristled brush under stereoscopic microscope.

A completely randomized design was used, consisting of seven treatments and four replicates. Each replicate consisted of one tomato leaflet.

The normality of variables was analyzed using the Shapiro Wilk test. Assays with immature *T. evansi* forms showed normal data and were analyzed using analysis of variance (ANOVA) and means were compared by the Tukey's test ($P<0.05$). Assays with adult females did not show data normality and were analyzed by the non-parametric Kruskal-Wallis test ($P<0.05$), comparing data distributions of treatments two by two. Data were submitted to analysis of variance using the SAS software (SAS Institute Inc. 2001).

RESULTS

The products that caused the highest mortality rate on immature *T. evansi* forms were Azamax® and garlic extract with 63.3% and 53.3%, respectively, followed by mastruz extract with 48.3%, neem and cow urine, both with 46.7% and manipueira with 23.3%. In the control (only water) mortality rate was 6.7% (Table 1).

Table 1. Mortality rate (Mean ± SE) of immature *Tetranychus evansi* forms after application of alternative products. Temperature of 25 ºC, RH ± 75% and 12-hour photophase.

Treatments	Mortality rate (%)
Azamax® (100%)	63.3 ± 5.77a
Alcoholic garlic extract (5%)	53.3 ± 11.22 ab
Alcoholic mastruz extract (5%)	48.3 ± 5.69 ab
Alcoholic neem extract (5%)	46.7 ± 5.44 ab
Cow urine (5%)	46.7 ± 6.08 ab
Manipueira (5%)	23.3 ± 5.77 bc
Control (distilled water)	6.7 ± 2.72 c
F (treatments)	8.814
CV (%)	31.74

[1] Means followed by the same letter do not differ from each other by the Tukey's test at 5% probability level.

In assays with adult tomato red mite females, treatment with Azamax® showed the highest mortality rate, with 38.3%, followed by garlic extract with 18.3% and mastruz extract with 15%. The lowest mortality rates were obtained with cow urine (11.7%), neem and manipueira (both with 6.7%) and control with 3.3% (Table 2).

Table 2. Mortality rate (Mean ± SE) of adult *Tetranychus evansi* females after application of alternative products. Temperature of 25 ºC, RH ± 75% and 12-hour photophase.

Treatments	Mortality rate
Azamax® (100%)	38.3 ± 5.69 a
Alcoholic garlic extract (5%)	18.3 ± 3.19 b
Alcoholic mastruz extract (5%)	15.0 ± 1.66 b
Alcoholic neem extract (5%)	11.7 ± 3.19 bc
Cow urine (5%)	6.7 ± 2.72 c
Manipueira (5%)	6.7 ± 2.72 c
Control (distilled water)	3.3 ± 1.92 c

[1] Means followed by the same letter do not differ from each other by the nonparametric Kruskal-Wallis test (P<0.05).

DISCUSSION

Treatment with Azamax® provided the highest mortality rate for both immature and adult *T. evansi* forms. Duarte et al. (2011) found that 1.0% Azamax® caused mortality rate of 44.57% in adult *T. urticae* females 24 hours after spraying. At the end of 120 hours, this index increased to 75.29%. Similar results were found by Brito et al. (2006), who reported that, among several neem-based products, Callneem® at 1.0% presented mortality of *T. urticae* of 43.8% after 24 hours. In a study carried out by Soto et al. (2010), it was possible to observe mortality of *T. evansi* above 95% using commercial products based on neem, Natuneem®, NeemPro® and Organic Neem®. Santos et al. (2017) used different Pure Neem Oil (Organix®) and Pironim Super® WG concentrations and found that these products showed acaricidal efficiency against *T. evansi.*

Garlic extract caused higher mortality in immature *T. evansi* forms. Freitas et al. (2009) observed mortality rate of 38% in adult *T. marinae* females after 48 hours of immersion of passion fruit leaves in the alcoholic garlic extract. Thus, garlic can be used as another natural defensive resource, with the advantage of being selective, with rapid degradation and short residual period, preserving natural enemies and their ecosystems (EMATER-MG, 2010). Since its main action on mites is repellency, the use of some garlic plants intercropped with tomato plants should be recommended. In some countries, it is already possible to use garlic oil obtained through industrial extraction on a large scale in commercial crops (EMATER-MG, 2010).

It was observed that mastruz extract caused acaricidal effect for both immature and adult forms. Similar results were obtained by Vieira et al. (2011), who used solutions containing mastruz essential oil (distilled water, castor oil + Tween® adhesive spreader) on adult spider mite females (*T. urticae*). Concentrations of 5 and 10% of this solution caused mortality rate of 31% and 61%, respectively. Chiasson et al. (2004) found that the formulation of the emulsifiable concentrate of *C. ambrosioides* essential oil at 0.5% presented mortality rate of 94.7% in adult *T. urticae* females.

Cow urine and manipueira showed higher mortality rates in immature forms than in adults. However, manipueira proved to be less efficient in both development stages. In the present work, the concentration used was lower than that usually applied (1: 2), which may have influenced the low efficiency of this product. Moreira et al. (2006) and Fernandes et al. (2008) reported that the acaricidal activity of manipueira occurs at the concentration of (1: 2).

In the work carried out by Santos (2008) using adult *Tetranychus abacae* females, Baker and Pritchard found that manipueira at concentrations of 25, 50 and 75% caused mortality rate of 62, 69 and 73%, respectively, 4 hours after the immersion of *Heliconia bihai* (L.) (Heliconiaceae) leaf discs in solutions.

Souza et al. (2010) reported the efficiency of cassava and cow urine in controlling the broad mite (*P. latus*) in *Jatropha curcas* L. (Euforbiaceae). The products used by these authors were stored for a period of eight and ten days, respectively, before being applied, which may have potentiated their action. According to Van Den Broek et al. (2002), to be used, cow urine must be stored under ambient conditions for at least three days in closed containers. In this study,

both cow urine and manipueira were used 24 hours after collection. This fact may have interfered with the mortality rates obtained.

Both manipueira and cow urine can be widely used to control pests in agriculture (Gonzaga et al., 2009). Cow urine, in addition to having insecticidal activity, is also considered an alternative to natural fertilizer and contains substances that improve plant health, making them more resistant to pests (PESAGRO-RIO, 2001). Manipueira, in addition to its insecticidal properties, acts as acaricide, fungicide (Ponte et al., 1992), nematicide (Ponte and Franco, 1981), fertilizer and herbicide (Fioretto, 2002).

In the present study, neem extract was more efficient for immature forms than for adult females. It is believed that the low efficiency of the neem extract in this experiment is probably related to the extraction method. According to Martinez (2002), green and dry neem leaves have lower azadirachtin concentration compared to concentration observed in seeds.

Unlike results obtained in the present work, Gonçalves et al. (2001) reported that aqueous neem extracts at concentrations of 2.5 and 5% were efficient in controlling immature *M. tanajoa* forms, causing mortality rate between 95 and 100% after 48 hours of evaluation. For adult females, neem extracts at concentrations of 2.5 and 5% caused mortality rate of 97.5 and 100%, respectively.

It is worth mentioning that neem extracts and, in particular, its most potent active ingredient, azadirachtin, can not only cause egg unviability and mortality of Arthropoda larvae and adults, but can also inhibit feeding. In addition, they can affect the development of larvae and delay their growth, reduce the fertility and fecundity of adults and alter behavior, causing several anomalies in cells and physiology of these organisms (Viegas Junior, 2003; Vivan, 2005; Caser et al., 2007).

All products used in this study showed acaricidal activity against *T. evansi*. The commercial product based on neem (Azamax®) showed the best results in the control of *T. evansi*, both in immature forms and adult females. Although Azamax® caused the highest mortality rate, there is no record in MAPA (Ministry of Agriculture, Livestock and Supply) for its use in the control of *T. evansi* in tomato (AGROFIT, 2011), requiring further studies, especially under field conditions. It is also worth mentioning that the information obtained through this work is preliminary, requiring future studies to clarify the real action of these plant extracts on the behavior of these mite species.

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