SELECTIVITY OF AGROCHEMICALS ON PREDATORY MITES (PHYTOSEIIDAE) FOUND ON COFFEE PLANTS

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ABSTRACT: An evaluation on the effect of agrochemicals to the predatory mites Euseius alatus DeLeon, 1966, Euseius citrifolius Denmark & Muma, 1970, Amblysieus herbicolus (Chant, 1959) and Iphiseiodes zuluagai Denmark & Muma, 1972 (Phytoseiidae) is presented in this paper. These predators are frequently associated to Brevipalpus phoenicis (Geijskes, 1939) (Acari: Tenuipalpidae), vector of the coffee ring spot virus, and to Oligonychus ilicis (McGregor, 1917) (Acari: Tetranychidae) on coffee plants. The residual contact bioassay of spraying in glass surface was used. Twenty-six currently used agrochemicals or those with potential to be used in Brazilian coffee production were tested. Spraying was conducted using a Potter tower at a pressure of 15 lb/pol²; each cover glass received 1.68 ± 0.36 mg/cm² of the tested products. Adverse effect on the predatory mites was calculated taking into account the mortality of females and the effect in the reproduction during eight days. Tested products were ranked in four toxicity classes according IOBC/WPRS, by the total effect caused to the mite. Five products (fenbutatin oxide, hexythiazox, spiromesifen, spirodiclofen and emamectin) were innocuous or slightly noxious to all predators, whereas three products (abamectin, sulfur and endosulfan) were innocuous or slightly noxious to three of the four predators.

Key words: Acari, phytoseiid, integrated pest management, Coffea arabica.

SELETIVIDADE DE PRODUTOS FITOSSANITÁRIOS A ÁCAROS PREDADORES (PHYTOSEIIDAE) ENCONTRADOS EM CAFÉEIRO


Palavras-chave: Acari, fitoseídeo, manejo integrado de pragas, Coffea arabica.

1 INTRODUCTION

Brevipalpus phoenicis (Geijskes, 1939) (Acari: Tenuipalpidae) is known in Brazil on coffee plants since 1951 (A INFESTAÇÃO, 1951). It was reported by (CHAGAS, 1973) as associated to the coffee ring spot, disease caused by a virus of the Rhabdovirus group (CHAGAS, 1988).

Since 1990, and particularly in 1995, infestations of B. phoenicis and occurrences of the coffee ring spot virus have been detected in the State of Minas Gerais causing intense defoliation of coffee plants (Coffea arabica L.), mainly in the Alto Paranaíba region (FIGUEIRA et al., 1996). The presence of the mite on coffee in other parts of Brazil has been reported (MATIELLO, 1987) on both Arabic (C. arabica) and Canephora coffee (Coffea canephora Pierre & Froenher).

The coffee red spider mite Oligonychus ilicis (McGregor, 1917) (Tetranychidae) was also reported in 1951, along with B. phoenicis, on C. arabica for the first time in Brazil (A INFESTAÇÃO…, 1951). This mite could cause heavy reduction in plant photosynthesis potential, causing reduced growth on new plantations (REIS & SOUZA, 1986). The coffee red spider mite was already referred to as the second...
most important pest in Conillon coffee (C. canephora) (IBC, 1985).

*Brevipalpus phoenicis* and *O. ilicis* are frequently found in association to the predatory mites *Euseius alatus* DeLeon, 1966, *Euseius citrifolius* Denmark & Muma, 1970, *Amblyseius herbicola* (Chant, 1959) and *Iphiseiodes zuluagai* Denmark & Muma, 1972 (Acari: Phytoseiidae) (PALLINI FILHO et al., 1992; REIS et al., 2000). Of the predatory mites, the Phytoseiidae are considered the most important and have been the most studied (McMURTRY & CROFT, 1997; MORAES, 1991).

For full success of the integrated pest mite management, in situations when agrochemicals are used as one of the control tactics, it is necessary that the products employed do not affect the predatory mites. Some works have shown the importance of studying products with selective properties for the preservation of species of predatory mites belonging to the family Phytoseiidae, taking into account the biological control as a tactic in integrated pest management programs (YAMAMOTO et al., 1992; SATO et al., 1996). Studies on the effect of chemicals on predatory mites should be implemented in the laboratory, semi-field and in the field. Tests of adverse effects of 42 agrochemicals on *I. zuluagai*, most of which used in Brazilian citrus (Citrus spp.) plantations, were carried out under laboratory conditions (REIS et al., 1998), showing that about 26% of the tested products were innocuous, 14% slightly noxious, 7% moderately noxious and 52% noxious to the mite. Similar tests on *E. alatus* (REIS et al., 1999) with 41 agrochemical products, most of them used in the same crop revealed that about 24.4% of the tested products were innocuous; 14.6% slightly noxious, 9.8% moderately noxious and 51.2% noxious to the mite. Some products influenced positively, whereas others negatively mite ovipositions.

The objective of the present work was to evaluate the effect of several agrochemicals on the main species of predatory mites (Phytoseiidae) found in coffee plantations.

**2 MATERIAL AND METHODS**

Twenty-six products currently used (COMPÊNDIO..., 2005) or likely to be used in coffee production in the form of leaf spraying for the control of pests or diseases, as well as fertilizers (Table 1) were tested in this work for the physiological selectivity to four species of predatory mites, *E. alatus*, *E. citrifolius*, *A. herbicola* and *I. zuluagai*.

**Origin of the mites.** The mites used in the tests were taken from laboratory colonies (REIS & ALVES, 1997), started with mites collected on unsprayed coffee plants, to avoid previous resistance selection pressure of them to the products tested.

**Application of agrochemical products.** The residual contact bioassay of spraying on glass surface was used as a recommended pattern for laboratory tests to evaluate adverse effects on predatory mites (HASSAN et al., 1994). It consisted of glass 20 x 20 mm cover slips, of the type used in microscopy, floating in water in a Petri dish (5-cm in diameter x 2-cm deep) without lid, as the surface for application of the products, where mites were kept. Spraying of the products was carried out on a Potter tower in the laboratory at a pressure of 15 lb /pol², with the spraying tower table at a distance of 1.7 cm from the spraying nozzle; each cover slip received 1.68±0.36 mg of the solution/cm². Such procedures are in conformity with those proposed by IOBC/WPRS (OVERMEER, 1988; HASSAN et al., 1994) that establishes a fresh deposit of solution from 1.5 to 2 mg /cm² on glass surfaces or leaves.

**Criteria used in the evaluation of the effect of the agrochemicals.** One hour after applying the products, five fertilized females were transferred, with a brush, to each cover glass slide (REIS et al., 1998). The total adverse effect (E %) was calculated taking into account the mortality in the treatment (corrected for mortality in the check treatment) and the effect in reproduction. According to Overmeer (1988) and Bakker et al. (1992), E % = 100% - (100% - M ) x E, where M = corrected mortality and E = effect in reproduction = R /R, were R = average production of eggs. The live females were counted daily during eight days as well as the number of viable eggs (those which gave origin to larvae), and the dead ones removed (REIS et al., 1998). Tests were only considered valid when the mortality of the check treatment was at the most around 20% (BAKKER et al., 1992). Tests were replicated six times.

The values found for the total effect for each tested product were classified in toxicity classes (TC) from 1 to 4, according to criteria established by IOBC/WPRS (BAKKER et al., 1992; HASSAN et al., 1994).

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Table 1 – Agrochemical products tested in relation to the effect on *Euseius alatus*, *Euseius citrifolius*, *Amblyseius herbicolus* and *Iphiseiodes zuluagai* (Acari: Phytoseiidae).

<table>
<thead>
<tr>
<th>Technical Product</th>
<th>Commercial Product</th>
<th>Formulation Concentration</th>
<th>Use</th>
<th>Toxicological Class</th>
<th>Chemical Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abamectin</td>
<td>Vertimec</td>
<td>CE 18</td>
<td>A</td>
<td>III</td>
<td>Lactone (Avermectin)</td>
</tr>
<tr>
<td>Azocyclotin</td>
<td>Peropal</td>
<td>PM 250</td>
<td>A</td>
<td>I</td>
<td>Organotin</td>
</tr>
<tr>
<td>Azocyclotin</td>
<td>Caligur</td>
<td>SC 500</td>
<td>A</td>
<td>II</td>
<td>Organotin</td>
</tr>
<tr>
<td>Bromopropylate</td>
<td>Neoron</td>
<td>CE 500</td>
<td>A</td>
<td>III</td>
<td>Benzilate</td>
</tr>
<tr>
<td>Cartap</td>
<td>Cartap</td>
<td>PM 500</td>
<td>I, F</td>
<td>III</td>
<td>Thiocarbamate</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>Lorsban</td>
<td>CE 480</td>
<td>I, A</td>
<td>II</td>
<td>Organophosphate</td>
</tr>
<tr>
<td>Copper hydroxide</td>
<td>Garant</td>
<td>PM 691</td>
<td>F</td>
<td>IV</td>
<td>Copper</td>
</tr>
<tr>
<td>Copper oxycylophene</td>
<td>Cuprogarbur</td>
<td>PM 840</td>
<td>F</td>
<td>IV</td>
<td>Copper</td>
</tr>
<tr>
<td>Copper sulfate</td>
<td>-</td>
<td>250</td>
<td>F</td>
<td>IV</td>
<td>Copper</td>
</tr>
<tr>
<td>Cuprous oxide</td>
<td>Copper Sandoz</td>
<td>PM 560</td>
<td>F</td>
<td>IV</td>
<td>Copper</td>
</tr>
<tr>
<td>Cyproconazole</td>
<td>Alto 100</td>
<td>CE 500</td>
<td>A</td>
<td>II</td>
<td>Organochlorine</td>
</tr>
<tr>
<td>Dicofol</td>
<td>Keltane</td>
<td>CE 480</td>
<td>A</td>
<td>II</td>
<td>Organochlorine</td>
</tr>
<tr>
<td>Dinocap</td>
<td>Karathane</td>
<td>CE 369</td>
<td>A</td>
<td>I</td>
<td>Dinitrophenol</td>
</tr>
<tr>
<td>Emamectin</td>
<td>Proclaim</td>
<td>SG 5</td>
<td>I</td>
<td>-</td>
<td>Lactone (Avermectin)</td>
</tr>
<tr>
<td>Endosulfan</td>
<td>Thiodan</td>
<td>CE 350</td>
<td>I, A</td>
<td>II</td>
<td>Organochlorine</td>
</tr>
<tr>
<td>Ethion</td>
<td>Ethion</td>
<td>CE 500</td>
<td>I, A</td>
<td>I</td>
<td>Organophosphate</td>
</tr>
<tr>
<td>Fenbutatin oxide</td>
<td>Torque</td>
<td>SC 500</td>
<td>A</td>
<td>III</td>
<td>Organotin</td>
</tr>
<tr>
<td>Hexythiazox</td>
<td>Savey</td>
<td>PM 500</td>
<td>A</td>
<td>III</td>
<td>Carboxamide</td>
</tr>
<tr>
<td>Propargite</td>
<td>Omite</td>
<td>CE 720</td>
<td>A</td>
<td>II</td>
<td>Phenoxy-cyclohexyl</td>
</tr>
<tr>
<td>Pyridaben</td>
<td>Sanmite</td>
<td>CE 200</td>
<td>A</td>
<td>I</td>
<td>Pyridazine</td>
</tr>
<tr>
<td>Pyrophosphoric extract</td>
<td>Biopirol</td>
<td>-</td>
<td>Fert.</td>
<td>-</td>
<td>Pyrophosphoric acid</td>
</tr>
<tr>
<td>Spirodiclofen</td>
<td>Envidor</td>
<td>SC 240</td>
<td>A</td>
<td>III</td>
<td>Tetronic acid</td>
</tr>
<tr>
<td>Spiromesifen</td>
<td>Oberon</td>
<td>SC 240</td>
<td>A</td>
<td>-</td>
<td>Tetronic acid</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Kumulus DF</td>
<td>DF 800</td>
<td>A, F</td>
<td>IV</td>
<td>Sulfur</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Thiovit</td>
<td>PM 800</td>
<td>A</td>
<td>IV</td>
<td>Sulfur</td>
</tr>
<tr>
<td>Triazophos + deltamearin</td>
<td>Deltaphos</td>
<td>CE 400</td>
<td>I, A</td>
<td>I</td>
<td>Organophosphate + pyrethroid</td>
</tr>
</tbody>
</table>

¹ g/kg or g/liter; ² A = acaricide; F = fungicide; I = insecticide; Fert. = fertilizer; ³ Brazil legal toxicological classes, “Lei 7.802/1989” regulated by the “Decreto 98.816/1990” of the “Ministério da Agricultura”: Class I - Extremely toxic; Class II - Highly toxic; Class III - Medium toxic and Class IV - Low toxicity.

(*) Information not available.

3 RESULTS AND DISCUSSION

From the 26 tested products, 15 (58%) had some degree of selectivity to the predatory mite *E. alatus*. Nine of the acaricides (35%) had some selectivity to the predator: three innocuous (class 1): emamectin, endosulfan and hexythiazox; three were slightly noxious (class 2): fenbutatin oxide, spirodiclofen and spiromesifen, and three moderately noxious (class 3) to the predator: abamectin, cartap and dinocap. Other six products (23%) with some degree of selectivity were fungicides: cyproconazole, copper hydroxide, copper oxycylophene and cuprous oxide (class 1), copper sulfate (class 3); and fertilizer: pyrophosphoric extract (class 1). The remaining eleven tested products (42%) were framed as noxious to the predatory mite (class 4) (Table 2).

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For the predatory mite *E. citrifolius*, 17 products (65%) presented some degree of selectivity. Eleven of the acaricides (42%), had some selectivity to the predator: three innocuous (class 1): fenbutatin oxide, hexythiazox and spiromesifen; six were slightly noxious (class 2): abamectin, cartap, emamectin, endosulfan, sulfur DF and spiromesifen, and two moderately noxious (class 3): bromopropylate and sulfur PM. Another six products (23%) with some degree of selectivity were fungicides: cyproconazole, copper hydroxide, copper oxychloride, cuprous oxide (class 1), copper sulfate (class 2); and fertilizer: pyrophosphoric extract (class 1). The remaining nine tested products (35%) were framed as noxious to the predatory mite (class 4) (Table 2).

For the predatory mite *A. herbicolus*, 14 products (54%) had some degree of selectivity. Eight of the acaricides (31%) had some selectivity to the predator: two innocuous (class 1): abamectin and emamectin; five slightly noxious (class 2): sulfur DF, fenbutatin oxide, hexythiazox, spiromesifen and spiromesifen, and one moderately noxious (class 3): dinocap. Another six products (23%) with some degree of selectivity were fungicides: copper hydroxide, copper oxychloride, cuprous oxide, cyproconazole (class 1), copper sulfate (class 3); and fertilizer: pyrophosphoric extract (class 1). The remaining twelve tested products (46%) were framed as noxious to the predatory mite (class 4) (Table 2).

For *I. zuluagai*, 20 products (77%) had some degree of selectivity. Thirteen of the acaricides (50%) had some selectivity: six innocuous (class 1): abamectin, sulfur DF, fenbutatin oxide, hexythiazox, spiromesifen and spiromesifen; six slightly noxious (class 2): emamectin, dinocap, azocyclotin PM, bromopropylate, endosulfan and sulfur PM, and one moderately noxious to the predator (class 3): azocyclotin SC. Another seven products (27%) with some degree of selectivity were fungicides: copper hydroxide, copper oxychloride, cuprous oxide, cyproconazole (class 1), copper sulfate (class 2); insecticide: cartap (class 2); and fertilizer: pyrophosphoric extract (class 1). The remaining six tested products (23%) were framed as noxious to the predatory mite (class 4) (Table 2).

*Iphiseiodes zuluagai* was the least affected predator (tolerant) to the tested agrochemicals; eleven of them were innocuous to the mite (class 1). It was followed by *E. alatus* and *E. citrifolius* with eight innocuous products, and *A. herbicolus* with six products (Table 2).

Selective products, in general, mainly those of class 1 (innocuous), had no effect on the reproduction of the mites (E with values close to 1), some even stimulating reproduction (E > 1) (Tables 2). This was already demonstrated by Reis & Sousa (2000) for some cupric fungicides.

Overall, five acaricides (fenbutatin oxide, hexythiazox, spiromesifen, spiromesifen and emamectin) were selective to all four predatory mites (classes 1 or 2), whereas three (abamectin, endosulfan) were selective to three predatory mites. From these, three are efficient ovicide products (hexythiazox, spiromesifen and spiromesifen) (REIS et al., 2003 and 2005), mainly for *B. phoenicis*, and one is an efficient acaricide (fenbutatin oxide) (REIS et al., 2004) for the post-embryonic phases of the pest-mites *B. phoenicis* and *O. ilicis*. Endosulfan, also selective, needs to be studied for its efficiency in the control of the pest-mites on coffee.

Laboratory tests like the ones performed in this study means very drastic situations for tested mites (full exposition to the product). Thus, it is expected that products shown to be innocuous to them in the tests will have the same effect under field conditions (FRANZ et al., 1980). The harmless classification of an agrochemical to predatory mites based on laboratory evaluation indicates that there is no need for additional tests, because practical experiences show that exceptions are rare, except through possible elimination of the prey, which would interfere with the survivorship of a specific natural enemy. On the other hand, the same does not apply to products classified as noxious in laboratory tests; in this case, field tests may still indicate the product to have acceptable effect on natural enemies (BAKKER et al., 1992). Thus, even the products that were classified as moderately noxious (class 3) in this study could be suitable for use in coffee pest management programs. Further support to this possibility should be obtained through complementary tests conducted under semi-field and field conditions.

Due to the existence of innocuous agrochemicals to predatory mites, one can state that it is possible to implement the integrated pest management strategy on coffee plantation with the use of chemicals as one of the tactics, thus controlling the pests and preserving their natural enemies.
Table 2 – Toxicity of agrochemicals to four species of phytoseiids, in residual laboratory tests at 25±2°C, 70±10% of RH and 14 hours of photophase (residue of 1.68±0.36 mg / cm² in glass surface).

<table>
<thead>
<tr>
<th>Technical name</th>
<th>Dosage / 100 liters of water</th>
<th>Effect in the reproduction / Toxicity class / Predator species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Euseius alatus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Abamectin</td>
<td>30ml</td>
<td>0.2</td>
</tr>
<tr>
<td>Azocyclotin PM</td>
<td>100g</td>
<td>-</td>
</tr>
<tr>
<td>Azocyclotin SC</td>
<td>50ml</td>
<td>-</td>
</tr>
<tr>
<td>Bromopropylate</td>
<td>40ml</td>
<td>-</td>
</tr>
<tr>
<td>Cartap</td>
<td>250g</td>
<td>2.0</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>250ml</td>
<td>-</td>
</tr>
<tr>
<td>Copper hydroxide</td>
<td>170g</td>
<td>1.1</td>
</tr>
<tr>
<td>Copper oxychloride</td>
<td>250g</td>
<td>1.0</td>
</tr>
<tr>
<td>Copper sulfate</td>
<td>600g</td>
<td>0.8</td>
</tr>
<tr>
<td>Cuprous oxide</td>
<td>150g</td>
<td>1.1</td>
</tr>
<tr>
<td>Cyproconazole</td>
<td>20ml</td>
<td>1.0</td>
</tr>
<tr>
<td>Dicofol</td>
<td>80ml</td>
<td>-</td>
</tr>
<tr>
<td>Dinocap</td>
<td>50ml</td>
<td>0.6</td>
</tr>
<tr>
<td>Emamectin</td>
<td>50g</td>
<td>0.9</td>
</tr>
<tr>
<td>Endosulfan</td>
<td>500ml</td>
<td>1.0</td>
</tr>
<tr>
<td>Ethon</td>
<td>150ml</td>
<td>-</td>
</tr>
<tr>
<td>Fenbutatin oxide</td>
<td>80ml</td>
<td>0.9</td>
</tr>
<tr>
<td>Hexythiazox</td>
<td>3g</td>
<td>0.8</td>
</tr>
<tr>
<td>Propargite</td>
<td>150ml</td>
<td>-</td>
</tr>
<tr>
<td>Pyridaben</td>
<td>75ml</td>
<td>-</td>
</tr>
<tr>
<td>Pyrophosphoric extract</td>
<td>500ml</td>
<td>1.0</td>
</tr>
<tr>
<td>Spirodiclofen</td>
<td>30 ml</td>
<td>0.2</td>
</tr>
<tr>
<td>Spiromesifen</td>
<td>60ml</td>
<td>0.7</td>
</tr>
<tr>
<td>Sulfur DF</td>
<td>500g</td>
<td>-</td>
</tr>
<tr>
<td>Sulfur PM</td>
<td>500g</td>
<td>-</td>
</tr>
<tr>
<td>Triazophos + deltamethrin</td>
<td>100ml</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>1</sup> E<sub>r</sub> = Effect in the reproduction. E<sub>r</sub> = R<sub>Treatment</sub> / R<sub>Check</sub>. where R = average production of eggs.

<sup>2</sup> TC = Toxicity classes according to IOBC/WPRS (BAKKER et al. 1992; HASSAN et al., 1994) as follows: class 1 = E < 30% (innocuous); class 2 = 30% < E < 79% (slightly noxious); class 3 = 80% < E < 99% (moderately noxious) and class 4 = E > 99% (noxious).

(-) Absence of value of E<sub>r</sub> (effect in the reproduction) is due to total mortality of the females (class 4 = noxious).

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5 BIBLIOGRAPHIC REFERENCES


