

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

Paulo Rebelles Reis¹, Renato André Franco², Marçal Pedro Neto², Adenir Vieira Teodoro²

(received: september 25, 2005; accepted: december 22, 2005)

ABSTRACT: An evaluation on the effect of agrochemicals to the predatory mites *Euseius alatus* DeLeon, 1966, *Euseius citrifolius* Denmark & Muma, 1970, *Amblyseius 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, spiroadiclofen 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 CAFEIEIRO

RESUMO: Neste estudo apresenta-se o resultado do efeito de produtos fitossanitários aos ácaros predadores *Euseius alatus* DeLeon, 1966, *Euseius citrifolius* Denmark & Muma, 1970, *Amblyseius herbicolus* (Chant, 1959) e *Iphiseiodes zuluagai* Denmark & Muma, 1972 (Phytoseiidae). Esses ácaros são encontrados em cafeeiros associados à *Brevipalpus phoenicis* (Geijskes, 1939) (Acari: Tenuipalpidae), vetor do vírus da mancha - anular, e a *Oligonychus ilicis* (McGregor, 1917) (Acari: Tetranychidae). Foi utilizado o bioensaio de contato residual de pulverização em superfície de vidro. Foram testados 26 produtos químicos em uso ou com potencial de uso na cafeicultura brasileira. A aplicação foi feita em torre de Potter a 15 lb/pol² de pressão e cada lâminula recebeu um depósito de calda de 1,68 ± 0,36 mg/cm². O efeito adverso ao ácaro predador foi calculado levando-se em conta a mortalidade de fêmeas e o efeito na reprodução durante oito dias. Os produtos foram classificados, quanto ao efeito total causado ao ácaro predador, em quatro classes de toxicidade propostas pela IOBC/WPRS. Considerando em conjunto produtos inócuos e levemente nocivos, porém eficientes no controle dos ácaros-praga do cafeeiro, cinco produtos (fenbutatin oxide, hexythiazox, spiromesifen, spiroadiclofen e emamectin) foram seletivos às quatro espécies de ácaros predadores estudadas, e três (abamectin, enxofre e endosulfan) a pelo menos três das quatro espécies.

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

¹ EPAMIG-CTSM/EcoCentro – Cx. P. 176 – 37200-000 – Lavras/MG – Pesquisador CNPq – paulo.rebelles@epamig.ufla.br

² Estudantes de Agronomia da Universidade Federal de Lavras/UFLA – CNPq e Consórcio CBP&D/Café.

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 herbicolus* (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. herbicolus* 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 /po², 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), $E \% = 100\% - (100\% - M_c) \times E_r$, where M_c = corrected mortality and E_r = effect in reproduction = $R_{\text{Treatment}} / R_{\text{Check}}$, where 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).

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

Technical Product	Commercial Product	Formulation Concentration ¹	Use ²	Toxicological Class ³	Chemical Group
Abamectin	Vertimec	CE 18	A	III	Lactone (Avermectin)
Azocyclotin	Peropal	PM 250	A	I	Organotin
Azocyclotin	Caligur	SC 500	A	II	Organotin
Bromopropylate	Neoron	CE 500	A	III	Benzilate
Cartap	Cartap	PM 500	I, F	III	Thiocarbamate
Chlorpyrifos	Lorsban	CE 480	I, A	II	Organophosphate
Copper hydroxide	Garant	PM 691	F	IV	Copper
Copper oxychloride	Cuprocarb	PM 840	F	IV	Copper
Copper sulfate	-	250	F	IV	Copper
Cuprous oxide	Copper Sandoz	PM 560	F	IV	Copper
Cyproconazole	Alto 100	SC 100	F	III	Triazole
Dicofol	Kelthane	CE 480	A	II	Organochlorine
Dinocap	Karathane	CE 369	A	I	Dinitrophenol
Emamectin	Proclaim	SG 5	I	-	Lactone (Avermectin)
Endosulfan	Thiodan	CE 350	I, A	II	Organochlorine
Ethion	Ethion	CE 500	I, A	I	Organophosphate
Fenbutatin oxide	Torque	SC 500	A	III	Organotin
Hexythiazox	Savey	PM 500	A	III	Carboxamide
Propargite	Omite	CE 720	A	II	Phenoxy-cyclohexyl
Pyridaben	Sanmite	CE 200	A	I	Pyridazinone
Pyrophosphoric extract	Biopirrol	-	Fert.	-	Pyrophosphoric acid
Spirodiclofen	Envidor	SC 240	A	III	Tetronic acid
Spiromesifen	Oberon	SC 240	A	-	Tetronic acid
Sulfur	Kumulus DF	DF 800	A, F	IV	Sulfur
Sulfur	Thiovit	PM 800	A	IV	Sulfur
Triazophos + deltamethrin	Deltaphos	CE 400	I, A	I	Organophosphate + pyrethroid

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 oxychloride 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).

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 spiroadiclofen, 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, spiroadiclofen 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, spiroadiclofen 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_r with values close to 1), some even stimulating reproduction ($E_r > 1$) (Tables 2). This was already demonstrated by Reis & Sousa (2000) for some cupric fungicides.

Overall, five acaricides (fenbutatin oxide, hexythiazox, spiromesifen, spiroadiclofen and emamectin) were selective to all the four predatory mites (classes 1 or 2), whereas three (abamectin, sulfur DF and endosulfan) were selective to three predatory mites. From these, three are efficient ovicide products (hexythiazox, spiroadiclofen 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 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).

Technical name	Dosage / 100 liters of water	Effect in the reproduction ¹ / Toxicity class ² / Predator species							
		<i>Euseius alatus</i>		<i>Euseius citrifolius</i>		<i>Amblyseius herbicolus</i>		<i>Iphiseiodes zuluagai</i>	
		E _r ¹	TC ²	E _r ¹	TC ²	E _r ¹	TC ²	E _r ¹	TC ²
Abamectin	30ml	0,2	3	1,0	2	0,8	1	1,1	1
Azocyclotin PM	100g	-	4	-	4	-	4	0,9	2
Azocyclotin SC	50ml	-	4	-	4	-	4	0,7	3
Bromopropylate	40ml	-	4	0,5	3	-	4	0,8	2
Cartap	250g	2,0	3	0,9	2	-	4	0,7	2
Chlorpyrifos	250ml	-	4	-	4	-	4	-	4
Copper hydroxide	170g	1,1	1	0,9	1	0,8	1	1,0	1
Copper oxychloride	250g	1,0	1	0,9	1	1,0	1	1,2	1
Copper sulfate	600g	0,8	3	0,7	2	0,8	3	1,5	2
Cuprous oxide	150g	1,1	1	1,0	1	0,9	1	1,3	1
Cyproconazole	20ml	1,0	1	0,9	1	0,6	2	0,9	1
Dicofol	80ml	-	4	-	4	-	4	-	4
Dinocap	50ml	0,6	3	-	4	0,7	3	5,3	2
Emamectin	50g	0,9	1	0,5	2	1,1	1	1,7	2
Endosulfan	500ml	1,0	1	1,1	2	-	4	0,6	2
Ethion	150ml	-	4	-	4	-	4	-	4
Fenbutatin oxide	80ml	0,9	2	1,0	1	1,7	2	1,0	1
Hexythiazox	3g	0,8	1	2,4	1	1,3	2	0,8	1
Propargite	150ml	-	4	-	4	-	4	-	4
Pyridaben	75ml	-	4	-	4	-	4	-	4
Pyrophosphoric extract	500ml	1,0	1	1,5	1	1,1	1	1,0	1
Spirodiclofen	30 ml	0,2	2	0,5	2	0,5	2	0,7	1
Spiromesifen	60ml	0,7	2	0,9	1	0,7	2	0,9	1
Sulfur DF	500g	-	4	1,6	2	1,0	2	1,2	1
Sulfur PM	500g	-	4	2,8	3	-	4	1,1	2
Triazophos + deltamethrin	100ml	-	4	-	4	-	4	-	4

¹ E_r = Effect in the reproduction. E_r = R_{Treatment} / R_{Check}, where R = average production of eggs.

² 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_r (effect in the reproduction) is due to total mortality of the females (class 4 = noxious).

4 ACKNOWLEDGMENTS

To “Consórcio Brasileiro de Pesquisa e Desenvolvimento do Café - CBP&D/Café” and “Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq” for the financial support and scholarship.

5 BIBLIOGRAPHIC REFERENCES

A INFESTAÇÃO de ácaros nos cafezais. **O Biológico**, São Paulo, v.17, n.7, p.130, 1951.

BAKKER, F.M.; GROVE, A.; BLÜMEL, S.; CALIS, J.; OOMEN, P. Side-effect test for phytoseiids and their rearing methods. **IOBC/WPRS Bulletin**, Montfavet, v.15, n.3, p.61-81, 1992.

CHAGAS, C.M. Associação do ácaro *Brevipalpus phoenicis* (Geijskes) à mancha anular do cafeeiro. **O Biológico**, São Paulo, v.39, n.9, p.229-232, 1973.

CHAGAS, C.M. Viroses, ou doenças semelhantes transmitidas por ácaros tenuipalpídeos: mancha anular do cafeeiro e leprose dos citros. **Fitopatologia Brasileira**, Brasília, v.13, n.2, p.92, 1988.

COMPÊNDIO de defensivos agrícolas: guia prático de produtos fitossanitários para uso agrícola. 7.ed. São Paulo: Organizações Andrei, 2005. 1142p.

FIGUEIRA, A.R.; REIS, P.R.; CARVALHO, V.L.; PINTO, C.S. Coffee ringspot virus is becoming a real problem to brazilian coffee growers. In: INTERNATIONAL CONGRESS OF VIROLOGY, 10., 1996. Jerusalem, Israel. **Abstracts...** Jerusalem, 1966. p.203.

FRANZ, J.M.; BOGENSCHÜTZ, H.; HASSAN, S.A.; HUANG, P.; NATON, E.; SUTER, H.; VIGGIANI, G. Results of a joint pesticide test programme by the working group: pesticides and beneficial arthropods. **Entomophaga**, Paris, v.25, n.3, p.231-236, 1980.

HASSAN, S.A.; BIGLER, F.; BOGENSCHÜTZ, H.; BOLLER, E.; BRUN, J.; CALIS, J.N.M.; COREMANS-PELSENEER, J.; DUSO, C.; GROVE, A.; HEIMBACH, U.; HELYER, N.; HOKKANEN, H.; LEWIS, G.B.; MANSOUR, F.; MORETH, L.; POLGAR, L.; SAMSØE-PETERSEN, L.; SAUPHANOR, B.; STÄUBLI, A.; STERK, G.; VAINIO, A.; VEIRE, M. van de; VIGGIANI, G.; VOGT, H. Results of the sixth joint

pesticide testing programme of the IOBC/WPRS - working group “Pesticides and Beneficial Organisms”. **Entomophaga**, Paris, v.39, n.1, p.107-119, 1994.

INSTITUTO BRASILEIRO DO CAFÉ. Cultivo do café conilon, p.527-556. In: INSTITUTO BRASILEIRO DO CAFÉ. **Cultura do café no Brasil**: manual de recomendações. Rio de Janeiro: IBC/GERCA, 1985. 580p.

MATTIELLO, J.B. Novas condições de ocorrência da mancha anular do cafeeiro. In: CONGRESSO BRASILEIRO DE PESQUISAS CAFEIRAS, 14., 1987, Campinas. **Resumos...** Rio de Janeiro: MIC/IBC, 1987. p.6.

McMURTRY, J.A.; CROFT, B.A. Life-styles of phytoseiid mites and their roles in biological control. **Annual Review of Entomology**, Palo Alto, v.42, p.291-321, 1997.

MORAES, G.J. Controle biológico de ácaros fitófagos. **Informe Agropecuário**, Belo Horizonte, v.15, n.167, p.56-621, 1991.

OVERMEER, W.P.J. Laboratory method for testing side-effects of pesticides on the predaceous mites *Typhlodromalus pyri* and *Amblyseius potentillae* (Acari: Phytoseiidae). **IOBC/WPRS Bulletin**, Montfavet, v.11, n.4, p.65-69, 1988.

PALLINI FILHO, A.; MORAES, G.J.; BUENO, V.H.P. Ácaros associados ao cafeeiro (*Coffea arabica* L.) no Sul de Minas Gerais. **Ciência e Prática**, Lavras, v.16, n.13, p.303-307, jul./set. 1992.

REIS, P.R.; ALTOÉ, B.F.; SOUZA, J.C. Efeito dos acaricidas spiromesifen (Oberon 240 SC) e azocyclotin (Caligur 500 SC) no controle dos ácaros da mancha - anular e vermelho do cafeeiro. In: CONGRESSO BRASILEIRO DE PESQUISAS CAFEIRAS, 29., 2003, Araxá. **Trabalhos Apresentados...** Rio de Janeiro: MAPA - SARC/PROCAFÉ, 2003. p.187-188.

REIS, P.R.; ALVES, E.B. Criação do ácaro predador *Iphiseiodes zuluagai* Denmark & Muma (Acari: Phytoseiidae) em laboratório. **Anais da Sociedade Entomológica do Brasil**, Itabuna, v.26, n.3, p.565-568, 1997.

Coffee Science, Lavras, v. 1, n. 1, p. 64-70, abr./jun. 2006

- REIS, P.R.; CHIAVEGATO, L.G.; MORAES, G.J.; ALVES, E.B.; SOUSA, E.O. Seletividade de agroquímicos ao ácaro predador *Iphiseiodes zuluagai* Denmark & Muma (Acari: Phytoseiidae). **Anais da Sociedade Entomológica do Brasil**, Itabuna, v.27, n.2, p.265-274, 1998.
- REIS, P. R.; PEDRO NETO, M.; FRANCO, R. A. Controle de *Brevipalpus phoenicis* (Geijskes, 1939) e *Oligonychus ilicis* (McGregor, 1917) (Acari: Tenuipalpidae, Tetranychidae) em cafeeiro e o impacto sobre ácaros benéficos. II - Spirodiclofen and Azocyclotin. **Ciência e Agrotecnologia**, Lavras, v.29, n.3, p.528-537, maio/jun. 2005.
- REIS, P.R.; PEDRO NETO, M.; FRANCO, R.A.; TEODORO, A.V. Controle de *Brevipalpus phoenicis* (Geijskes, 1939) e *Oligonychus ilicis* (McGregor, 1917) (Acari: Tenuipalpidae, Tetranychidae) em cafeeiro e o impacto sobre ácaros benéficos. I - Abamectin e emamectin. **Ciência e Agrotecnologia**, Lavras, v.28, n.2, p.271-283, mar./abr. 2004.
- REIS, P.R.; SOUSA, E.O. Efeito de oxiclreto de cobre sobre duas espécies de ácaros predadores. **Ciência e Agrotecnologia**, Lavras, v.24, n.4, p.927-930, out./dez., 2000.
- REIS, P.R.; SOUSA, E.O.; ALVES, E.B. Seletividade de produtos fitossanitários ao ácaro predador *Euseius alatus* DeLeon (Acari: Phytoseiidae). **Revista Brasileira de Fruticultura**, Jaboticabal, v.21, n.3, p.350-355, dez. 1999.
- REIS, P.R.; SOUZA, J.C. Pragas do cafeeiro, p.338-378. In: RENA, A.B.; MALAVOLTA, E.; ROCHA, M.; YAMADA, T. (Ed.) **Cultura do cafeeiro**; fatores que afetam a produtividade. Piracicaba: POTAFOS, 1986. 447p.
- REIS, P.R.; SOUZA, J.C.; PEDRO NETO, M.; TEODORO, A.V. Flutuação populacional do ácaro da mancha - anular do cafeeiro e seus inimigos naturais. In: SIMPÓSIO DE PESQUISA DOS CAFÉS DO BRASIL, Poços de Caldas, 2000. **Resumos Expandidos...** Brasília: EMBRAPA-CAFÉ, 2000. v.2. p.1210-1212.
- SATO, M.E.; CERÁVOLO, L.C.; ROSSI, A.C.; RAGA, A.; SOUZA FILHO, M.F. de. Toxicidade residual de acaricidas a *Iphiseiodes zuluagai* Denmark & Muma, 1972 (Acari: Phytoseiidae). **Arquivos do Instituto Biológico**, São Paulo, v.63, n.1, p.15-19, 1996.
- YAMAMOTO, P.T.; PINTO, A. de S.; PAIVA, P.E.B.; GRAVENA, S. Seletividade de agrotóxicos aos inimigos naturais de pragas dos citros. **Laranja**, Cordeirópolis, v.13, n.2, p.709-755, 1992.