Agricultural Sciences, 2014, 5, 298-303
Published Online March 2014 in SciRes. http://www.scirp.org/journal/as
http://dx.doi.org/10.4236/as.2014.54032

Scientific Research

Cyazypyr™ Selectivity for Three Species of Phytoseiid for Coffee and Other Relevant Agricultural Crops in Brazil

Paulo Rebelles Reis[1*], Melissa Alves Toledo[2], Fábio M. Andrade Silva[3]

[1]EPAMIG/EcoCentro, Lavras, Brazil
[2]Universidade Federal de Lavras, Lavras, Brazil
[3]DuPont do Brasil S.A.-Agricultura e Nutrição, Paulínia, Brazil
Email: [*]paulo.rebelles@epamig.ufla.br

Received 14 January 2014; revised 18 February 2014; accepted 6 March 2014

Abstract

Mites belonging to the family Phytoseiidae are the most important and most widely studied among predatory mites of phytophagous mites. The phytophagous mites *Brevipalpus phoenicis* (Geijskes, 1939) (Tenuipalpidae) and *Oligonychus ilicis* (McGregor, 1917) (Tetranychidae) on coffee (*Coffea* spp.), are frequently found in combination with the predaceous mites *Iphiseiodes zuluagai* Denmark & Muma, 1972; *Euseius alatus* DeLeon, 1966 and *Amblyseius herbicolus* (Chant, 1959) (Acari: Phytoseiidae), among others. The purpose of this research was to study the effects of the product Cyazypyr™ (cyantraniliprole 100 OD) on these three species of Phytoseiidae, relevant to coffee, citrus and other agricultural crops in Brazil, following standard laboratory procedures. Mated female mites were exposed to fresh-dried residues on a glass surface, with 8 treatments, 5 mites per glass plate and 6 replicates, in a completely randomized experimental design. Each test lasted eight days, with a daily count of the surviving females and of eggs laid. Cyazypyr™, in all tested doses (75, 100, 125, 150, 175 and 200 g a.i./ha), was selective for the studied species, *A. herbicolus*, *I. zuluagai*, and *E. alatus*. Overall the treatments resulted in low mortality rates and negligible impact on the reproduction. Therefore, based on IOBC standards, Cyazypyr™ can be classified as not harmful (class 1) or slightly harmful (class 2), comparable to the agrochemical Talento™ (hexythiazox 500 WP-12 g a.i./ha) equivalent to a harmless standard of selectivity in the laboratory. Cyazypyr™ is therefore a complement to programs of integrated pest management, to preserve the populations of predatory mites in crops of coffee and citrus, among others, in Brazil.

Keywords

Agricultural Acarology; Cyantraniliprole; *Coffea arabica*; *Citrus sinensis*; Predaceous Mites;

[*]Corresponding author.

How to cite this paper: Reis, P.R., Toledo, M.A. and Silva, F.M.A. (2014) Cyazypyr™ Selectivity for Three Species of Phytoseiid for Coffee and Other Relevant Agricultural Crops in Brazil. *Agricultural Sciences*, **5**, 298-303.
http://dx.doi.org/10.4236/as.2014.54032

Ryanodine; Anthranilic Diamides

1. Introduction

Mites belonging to the family Phytoseiidae are the most important and most widely studied among predatory mites of phytophagous mites [1] [2].

The phytophagous mites *Brevipalpus phoenicis* (Geijskes, 1939) (Tenuipalpidae) and *Oligonychus ilicis* (McGregor, 1917) (Tetranychidae), on coffee (*Coffea* spp.) crops, are frequently found in combination with the predaceous mites *Iphiseiodes zuluagai* Denmark & Muma, 1972; *Euseius alatus* DeLeon, 1966 and *Amblyseius herbicolus* (Chant, 1959) (Acari: Phytoseiidae) among others [3] [4].

On citrus (*Citrus* spp.) crops, the species of Phytoseiidae most often mentioned as being frequently associated with the pest mites *Phyllocoptruta oleivora* (Asmead, 1879) (Eriophyidae), and particularly *B. phoenicis* are, *E. alatus*, *A. herbicolus*, *I. zuluagai*, *Amblyseius compositus* Denmark & Muma, 1973, *Euseius citrifolius* Denmark & Muma, 1970, and *Euseius concordis* (Chant, 1959) among others [5]-[9].

For complete success in the integrated management of mites, with the use of agrochemicals being one tactic, the products used must not affect predaceous mites, and studies in this regard have been developed in both the laboratory and the field [10].

Cyazypyr^{TM} (cyantraniliprole) is a new anthranilic diamide insecticide developed worldwide by E.I. DuPont de Nemours and Company, Inc. with a novel mode of action. It is a second generation RyR (action only by activating ryanodine receptors) insecticide with a similar mode of action to Rynaxypyr^{TM} (chlorantraniliprole) [11]. Cyazypyr^{TM} activates ryanodine receptors via stimulation of the release of calcium stores from the sarcoplasmic reticulum of muscle cells (*i.e.* for chewing insect pests) causing impaired regulation, paralysis and ultimately death of sensitive species. It is active on chewing pests primarily by ingestion and secondarily by contact and demonstrates good ovi-larvicidal and larvicidal activity. In Europe, Rynaxypyr^{TM} has been developed for foliar applications in top fruit, vegetable crops, grapes and potatoes at rates of 10 to 60 g a.i./ha, which are highly effective on many important pests yet selective to predatory mites and other beneficial arthropods [12] [13]. In Brazil, since 2006 (Cyazypyr^{TM}) cyantraniliprole was tested for its efficacy to control pests of bean, maize, sugar cane, cotton, citrus fruit, tomatoes, potatoes, oats, melons, rice, wheat and coffee [14] and it is logical to consider the IPM fit of Cyazypyr^{TM} for these crops.

The purpose of this research was to study the effects of the product Cyazypyr^{TM} (cyantraniliprole 100 OD) on three species of predaceous mites belonging to the Phytoseiidae family, while taking exposure factors into account.

2. Material and Methods

2.1. Mites Rearing

The mites used in these studies came from colonies reared in laboratory [15], which originated from mites taken from coffee trees that had never been sprayed with pesticides to ensure that the research was done on a population that did not experience any selective pressure toward pesticide resistance.

2.2. Laboratory (Bio-Tests)

The method used was residual spraying on a glass surface, which is the recommended standard for laboratory testing of adverse effects on predaceous mites [16]. Cover slips of glass measuring 20 × 20 mm, of the type used in microscopy, floating in water in a Petri dish measuring 5 cm in diameter × 2 cm in depth, uncovered, were used as a surface for the application of the products, and as a support for the mites. Under these conditions, the slide remained more or less in the center of the dish, not touching its sides, with the water being present for the mites to ingest and to prevent them from escaping.

2.3. Application of the Pesticides

The products were sprayed in a laboratory Potter tower at a pressure of 15 psi, with the tower's spraying table at a distance of 1.7 cm from the spraying tube. Each cover slip received a deposit of spray of about 1.7 mg/cm^2. These procedures are in compliance with the recommendations of the IOBC/WPRS [17] [18], which provides for a fresh deposit of 1.5 to 2 mg/cm^2 of spray for glass surfaces or leaves. This amount of product was obtained by repeated weighing of a glass slide after being sprayed with water, on a scale with an accuracy of 0.01 mg.

After application of the test products, the slides were placed to dry, under laboratory conditions for about one hour, and then placed in water where they received a small amount of castor bean pollen (*Ricinus communis* L.) as food for the surviving mites. Five mated females were transferred, to each cover slip with the aid of a fine camel brush.

For each species of predaceous mite, Cyazypyr™ [cyantraniliprole 100 OD] (oil dispersion)] was tested in six concentrations and Talento™ (hexythiazox 500 WP-1200 g a.i./ha) was tested in one concentration (standard of selectivity in the experiment), with six replications each, using a completely randomized experimental design.

2.4. Criteria Used in Evaluating the Effect of the Tested Products

Each test remained eight days, with a daily count of the live females and the number of eggs laid that resulted in viable larvae, and dead females were removed. The adverse or total effect (E%) was calculated by taking into account mortality in treatment, corrected in function of the control mortality, and the effect on reproduction, according to [17] and according to the IOBC/WPRS [19], with: $E\% = 100\% - (100\% - M_c) \times E_r$, were: M_c = corrected mortality [20] and E_r = effect on reproduction.

The effect on reproduction (E_r) was obtained by dividing the average egg production of the females in treatment (R) by the egg production in the control group $\left(E_r = R_{\text{Treatment}} / R_{\text{Control}}\right)$. The average egg production per female (R) was obtained by the relationship: $R = \text{number of viable eggs} / \text{number of live females}$.

Were considered valid only the tests where the mortality in the control plot was ≤20% [19].

The total effect values found for each product were classified in Classes 1 to 4 according to the criteria established by the IOBC/WPRS for classifying plant protection products on the basis of the adverse effect caused to beneficial organisms in laboratory tests [18] [19], which are: Class 1 = $E < 30\%$ (innocuous, not harmful), Class 2 = $30\% \le E \le 79\%$ (slightly harmful), Class 3 = $80\% \le E \le 99\%$ (moderately harmful), and Class 4 = $E > 99\%$ (harmful).

3. Results and Discussion

The product can be classified as not harmful (toxicity class 1), to the mite *A. herbicolus* between 75 and 125 g of a.i./ha, and class 2 between 150 and 200 g of a.i./ha, similar to the hexythiazox (Talento™) which is the standard of selectivity in the experiment. The results of the effect of the tested products on predaceous mites are presented in **Table 1**.

The product can be classified as not harmful (toxicity class 1) to *Iphiseiodes zuluagai*, with similarity to the hexythiazox (Talento™) standard of selectivity in the experiment. The results of the effect of the tested products on this predaceous mite are presented in **Table 2**.

Except the doses 150 and 175 g a.i./ha, class 2 for *E. alatus*, the other Cyazypyr™ doses and that of the hexythiazox (Talento™) presented class 1 of toxicity for this species of predaceous mite (**Table 3**).

In general, all the treatments caused low mortality rates among mites and a low impact on their reproduction.

Of the three species of predaceous mites in the study, the most sensitive was *A. herbicolus*, followed by *E. alatus*, however, the total effect (E%) was near 30%, threshold for the loss of safety. The most resistant of the three predatory mites was *I. zuluagai* with total effect lower than 15.5% for all doses of cyantraniliprole and most of the times lower than the control treatment, hexythiazox. The mortality effect was always low, mainly for *I. zuluagai*. No negative effect, for all doses of cyantraniliprole, was observed on the reproduction of any of the three predatory mite species studied (**Tables 1-3**).

Cyantraniliprole 100 OD is proposed for use at field concentrations that range between 0.5 to 5000 mg of a.i. /liter, in chemical control of insects (Lepidoptera) caterpillar, beetles (Coleoptera), aphids or shield bugs from the family Pentatomidae (Hemiptera) and other pests [11]-[14]. Is highly potent and efficacious against a wide range of economically important Lepidoptera species, and is also effectively in control species from other orders such as Diptera and Isoptera.

In this worst-case protocol, with full exposure of predatory mites to the product Cyazypyr™, was shown to be harmless (toxicity class 1) or slightly harmful (class 2). Tier 1 laboratory tests are designed as worst-case expo-

Table 1. Toxicity of Cyazypyr™ (cyantraniliprole 100 OD) on the phytoseiid predatory mite *Amblyseius herbicolus* in a residual laboratory toxicity test at 25˚C ± 2˚C, 70% ± 10% RH, and 14 photophase hours (residue of 1.68 ± 0.36 mg/cm² on a glass surface) (n = 30).

Treatments	Dose g a.i./ha[1]	M_c[2](%)	R[3]	E_r[4]	E[5](%)	Class[6]
Control (water)	-	-	4.67	-	-	-
Cyantraniliprole 100 OD	75	40.70	7.94	1.7	0.00	1
Cyantraniliprole 100 OD	100	2.20	7.10	1.5	0.00	1
Cyantraniliprole 100 OD	125	7.41	3.70	0.8	26.19	1
Cyantraniliprole 100 OD	150	37.00	4.60	1.0	37.30	2
Cyantraniliprole 100 OD	175	51.90	4.80	1.0	50.00	2
Cyantraniliprole 100 OD	200	25.90	3.70	0.8	42.06	2
Hexythiazox 500 WP	12	37.00	3.90	0.8	47.61	2

[1]g of active ingredient/ha. [2]M_c = corrected mortality (%). M_c = (live mites tested-live mites treated)/live mites tested × 100. [3]R = average egg production/females. R = No. viable eggs/No. females. [4]Effect on reproduction. $E_r = R_{Treatment}/R_{Control}$. [5]Total or adverse effect. $E = 100\% - (100\% - M_c) \times E_r$. [6]Classes of toxicity according to the IOBC/WPRS: class 1 = $E < 30\%$ (innocuous, not harmful); class 2 = $30 \leq E \leq 80$ (slightly harmful); class 3 = $80 \leq E \leq 99$ (moderately harmful), and class 4 = $E > 99\%$ (harmful).

Table 2. Toxicity of Cyazypyr™ (cyantraniliprole 100 OD) on the phytoseiid predatory mite *Iphiseiodes zuluagai* in a residual laboratory toxicity test at 25˚C ± 2˚C, 70% ± 10% RH, and 14 photophase hours (residue of 1.68 ± 0.36 mg/cm² on a glass surface) (n = 30).

Treatments	Dose g a.i./ha[1]	M_c[2] (%)	R[3]	E_r[4]	E[5] (%)	Class[6]
Control (water)	-	-	1.30	-	-	-
Cyantraniliprole 100 OD	75	5.00	1.32	1.0	3.85	1
Cyantraniliprole 100 OD	100	30.00	1.57	1.2	15.38	1
Cyantraniliprole 100 OD	125	5.00	1.20	0.9	11.54	1
Cyantraniliprole 100 OD	150	−5.00	1.00	0.8	15.38	1
Cyantraniliprole 100 OD	175	15.00	1.40	1.1	7.69	1
Cyantraniliprole 100 OD	200	−30.00	1.00	0.7	3.85	1
Hexythiazox 500 WP	12	−20.00	0.90	0.7	15.38	1

[1]g of active ingredient/ha. [2]M_c = corrected mortality (%). M_c = (live mites tested-live mites treated)/live mites tested × 100. [3]R = average egg production/females. R = No. viable eggs/No. females. [4]Effect on reproduction. $E_r = R_{Treatment}/R_{Control}$. [5]Total or adverse effect. $E = 100\% - (100\% - M_c) \times E_r$. [6]Classes of toxicity according to the IOBC/WPRS: class 1 = $E < 30\%$ (innocuous, not harmful); class 2 = $30 \leq E \leq 80$ (slightly harmful); class 3 = $80 \leq E \leq 99$ (moderately harmful), and class 4 = $E > 99\%$ (harmful).

Table 3. Toxicity of Cyazypyr™ (cyantraniliprole 100 OD) on the phytoseiid predatory mite *Euseius alatus* in a residual laboratory toxicity test at 25˚C ± 2˚C, 70% ± 10% RH, and 14 photophase hours (residue of 1.68 ± 0.36 mg/cm² on a glass surface) (n = 30).

Treatments	Dose g a.i./ha[1]	M_c[2] (%)	R[3]	E_r[4]	E[5] (%)	Class[6]
Control (water)	-	-	2.93	-	-	-
Cyantraniliprole 100 OD	75	6.90	2.59	0.9	17.65	1
Cyantraniliprole 100 OD	100	3.45	2.25	0.8	25.88	1
Cyantraniliprole 100 OD	125	13.80	3.40	1.2	0.00	1
Cyantraniliprole 100 OD	150	34.50	3.10	1.0	31.76	2
Cyantraniliprole 100 OD	175	44.80	3.70	1.3	30.59	2
Cyantraniliprole 100 OD	200	44.80	3.90	1.3	25.88	1
Hexythiazox 500 PM	12	24.10	3.20	1.1	17.65	1

[1]g of active ingredient/ha. [2]M_c = corrected mortality (%). M_c = (live mites tested-live mites treated)/live mites tested × 100. [3]R = average egg production/females. R = No. viable eggs/No. females. [4]Effect on reproduction. $E_r = R_{Treatment}/R_{Control}$. [5]Total or adverse effect. $E = 100\% - (100\% - M_c) \times E_r$. [6]Classes of toxicity according to the IOBC/WPRS: class 1 = $E < 30\%$ (innocuous, not harmful); class 2 = $30 \leq E \leq 80$ (slightly harmful); class 3 = $80 \leq E \leq 99$ (moderately harmful), and class 4 = $E > 99\%$ (harmful).

sure experiments to test lethal and sub-lethal effects [21]. A harmless or selective classification result indicates that there is no need for additional testing. It can be expected that products demonstrating selectivity in laboratory tests will demonstrate a similar effect under greenhouse and field conditions [10]-[22].

The product Cyazypyr™ (cyantraniliprole 100 OD), in all tested doses, was selective for the three species of phytoseiids studied, *A. herbicolus*, *1. zuluagai* and *E. alatus* in laboratory tests, so no need more tests in semi-field or field conditions for selectivity.

4. Conclusion

Cyantraniliprole 100 OD is an excellent product for use as a tactic in an integrated pest management strategy, since it was found to be innocuous or slightly harmful on predaceous mites of the Phytoseiidae family that are naturally occurring in various crops, as well as coffee and citrus, among others, in Brazil.

Acknowledgements

For *DuPont do Brasil S.A.-Agricultura e Nutrição* for the financial support, *CNPq* and *INCT do Café CNPq-Fapemig* for the fellowship.

References

[1] McMurtry, J.A. and Croft, B.A. (1997) Life-Styles of Phytoseiid Mites and Their Roles in Biological Control. *Annual Review of Entomology*, **42**, 291-321. http://dx.doi.org/10.1146/annurev.ento.42.1.291

[2] Moraes, G.J. (1991) Controle biológico de ácaros fitófagos. *Informe Agropecuário*, **15**, 56-62.

[3] Pallini Filho, A., Moraes, G.J. and Bueno, V.H.P. (1992) Ácaros associados ao cafeeiro (*Coffea arabica* L.) no Sul de Minas Gerais. *Ciência e Prática*, **16**, 303-307.

[4] Reis, P.R., Souza, J.C., Pedro Neto, M. and Teodoro, A.V. (2000) Flutuação populacional do ácaro da mancha-anular do cafeeiro e seus inimigos naturais. *Resumos Expandidos do Simpósio de Pesquisa dos Cafés do Brasil*, *Poços de Caldas*, *Embrapa Café*, **2**, 1210-1212.

[5] Komatsu, S.S. and Nakano, O. (1988) Estudos visando o manejo do ácaro da leprose em citros através do ácaro predador *Euseius concordis* (Acari: Phytoseiidae). *Laranja*, **9**, 125-146.

[6] Moreira, P.H.R. (1993) Ocorrência, dinâmica populacional de ácaros predadores em citros e biologia de *Euseius citrifolius* (Acari: Phytoseiidae). Dissertação (Mestrado em Entomologia), FCAVJ/UNESP, Jaboticabal.

[7] Gravena, S., Benetoli, I., Moreira, P.H.R. and Yamamoto, P.T. (1994) *Euseius citrifolius* Denmark & Muma Predation on Citrus Leprosis Mite *Brevipalpus phoenicis* (Geijskes) (Acari: Phytoseiidae: Tenuipalpidae). *Anais da Sociedade Entomológica do Brasil*, **23**, 209-218.

[8] Sato, M.E., Raga, A., Cerávolo, L.C., Rossi, A.C. and Potenza, M.R. (1994) Ácaros em pomar cítrico de Presidente Prudente, Estado de São Paulo. *Anais da Sociedade Entomológica do Brasil*, **23**, 435-441.

[9] Reis, P.R., Chiavegato, L.G., Alves, E.B. and Sousa, E.O. (2000) Ácaros da família Phytoseiidae associados aos citros no município de Lavras, Sul de Minas Gerais. *Anais da Sociedade Entomológica do Brasil*, **29**, 95-104. http://dx.doi.org/10.1590/S0301-80592000000100012

[10] Reis, P.R., Franco, R.A., Pedro Neto, M. and Teodoro, A.V. (2006) Selectivity of Agrochemicals on Predatory Mites (Phytoseiidae) Found on Coffee Plants. *Coffee Science*, **1**, 64-70.

[11] Fetting, C.J., Hayes, C.J., McKelvey, S.R. and Mori, S.R. (2011) Laboratory Assays of Select Candidate Insecticides for Control of *Dendroctonus ponderosae*. *Pest Management Science*, **67**, 548-555. http://dx.doi.org/10.1002/ps.2094

[12] Dinter, A., Brugger, A., Bassi, A., Frost, N.M. and Woodward, M.D. (2008) Cyantraniliprole (DPX-E2Y45, DuPont™, Rynaxypyr®, Coragen®, and Altacor® Insecticide—A Novel Anthranilic Diamide Insecticide Demonstrating Low Toxicity and Low Risk for Beneficial Insects and Predatory Mites. *IOBC/WPRS Bulletin*, **35**, 128-136.

[13] Lahm, G.P., Stevenson, T.M., Selby, T.P., Freudenberger, J.H., Cordova, D., Flexner, L., Bellin, C.A., Dubas, C.M., Smith, B.K., Hughes, K.A., Hollingshaus, J.G., Clark, C.E. and Benner, E.A. (2007) Rynaxypyr™: A New Insecticidal Anthranilic Diamide that Acts as a Potent and Selective Ryanodine Receptor Activator. *Bioorganic & Medicinal Chemistry Letters*, **17**, 6274-6279. http://dx.doi.org/10.1016/j.bmcl.2007.09.012

[14] Legocki, J., Połeć, I. and Żelechowski, K. (2008) Contemporary Trends in Development of Active Substances Possessing the Pesticidal Properties: Ryanodine-Receptor Targeting Insecticides. *Pestycydy*, **3-4**, 15-16.

[15] Reis, P.R. and Alves, E.B. (1997) Criação do ácaro predador *Iphiseiodes zuluagai* Denmark & Muma (Acari: Phytoseiidae) em laboratório. *Anais da Sociedade Entomológica do Brasil*, **26**, 565-568.

http://dx.doi.org/10.1590/S0301-80591997000300021

[16] Reis, P.R., Chiavegato, L.G., Moraes, G.J., Alves, E.B. and Sousa, E.O. (1998) Seletividade de agroquímicos ao ácaro predador *Iphiseiodes zuluagai* Denmark & Muma (Acari: Phytoseiidae). *Anais da Sociedade Entomológica do Brasil*, **27**, 265-274. http://dx.doi.org/10.1590/S0301-80591998000200013

[17] Overmeer, W.P.J. (1988) Laboratory Method for Testing Side-Effects of Pesticides on the Predaceous Mites *Typhlodromalus pyri* and *Amblyseius potentillae* (Acari: Phytoseiidae). *IOBC/WPRS Bulletin*, **11**, 65-69.

[18] Hassan, S.A., Bigler, F., Bogenschütz, H., Boller, E., Brun, J., Calis, J.N.M., Coremans-Pelseneer, J., Duso, C., Grove, A., Heimbch, 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., Van de Veire, M., Viggiani, G. and Vogt, H. (1994) Results of the Sixth Joint Pesticide Testing Programme of the IOBC/WPRS—Working Group "Pesticides and Beneficial Organisms". *Entomophaga*, **39**, 107-119. http://dx.doi.org/10.1007/BF02373500

[19] Bakker, F.M., Grove, A., Blümel, S., Calis, J. and Oomen, P. (1992) Side-Effect Test for Phytoseiids and Their Rearing Methods. *IOBC/WPRS Bulletin*, **15**, 61-81.

[20] Abbott, W.S. (1925) A Method of Computing the Effectiveness of an Insecticide. *Journal of Economic Entomology*, **18**, 265-267.

[21] Blümel, S., Bakker, F.M., Baier, B., Brown, K., Candolfi, M.P., Gobmann, A., Grimm, C., Jackel, B., Nienstedt, K., Schirra, K.J., Ufer, A. and Waltersdorfer, A. (2000) Laboratory Residual Contact Test with the Predatory Mite *Typhlodromus pyri* Scheuten (Acari: Phytoseiidae) for Regulatory Testing of Plant Protection Products. In: Candolfi, M.P., Blümel, S., Forster, R., Bakker, F.M., Grimm, C., Hassan, S.A., Heimbach, U., Mead-Briggs, M.A., Reber, B., Schmuck, R. and Vogt, H., Eds., *Guidelines to Evaluate Side-Effects of Plant Protection Products to Non-Target Arthropods*, *IOBC, BART and EPPO Joint Initiative*, IOBC/WPRS, Gent, 121-144.

[22] Franz, J.M., Bogenschutz, H., Hassan, S.A., Huang, P., Naton, P., Suter, H. and Viggiani, G. (1980) Results of a Joint Pesticide Test Programme by the Working Groups; Pesticides and Beneficial Arthropods. *Entomophaga*, **25**, 231-236. http://dx.doi.org/10.1007/BF02371922