

Comparison of insecticide toxicity in adults of the fruit flies

Anastrepha fraterculus (Wied.) and *Anastrepha grandis*

(Macquart) (Tephritidae)

ABSTRACT

Fruit flies (Diptera: Tephritidae) of economic and quarantine importance are responsible for quantitative and qualitative losses in horticulture. Most of producers spray insecticides in coverage for the control of fruit flies in Brazil. New insecticide molecules were evaluated under laboratory conditions to replace organophosphates and provide protection and sanity to horticultural crops. Five couples of *Anastrepha fraterculus* (Wied.) and *Anastrepha grandis* (Wied.) were disposed into petri dishes and exposed to eight insecticides under Potter tower. The number of dead insects was evaluated until 21 hours after spraying. In general, both *Anastrepha* species showed similar susceptibility to the insecticides. Different fruit fly mortalities were observed among the insecticide treatments from 30 minutes after exposure. Interactions were verified between the compounds and fruit fly species and between evaluation periods and treatments. Acetamiprid, deltamethrin, flypyradifurone (1.60 ppm), imidacloprid, phosmet, thiamethoxam and zeta-cypermethrin caused similar mortalities 21 hours after treatment for both fruit flies species.

Keywords: Diptera, fruit fly, pesticides, mortality, adulticide.

1. INTRODUCTION

South American fruit fly, *Anastrepha fraterculus* (Wied.) and South American cucurbit fruit fly, *Anastrepha grandis* (Macquart) are important pests of fruits and cucurbit crops, respectively, in Latin American countries [1, 2, 3]. *Anastrepha fraterculus* attacks 116 host plants in Brazil [4], while *A. grandis* infests exclusively wild and commercial cucurbit fruits, especially species and hybrids of *Cucurbita* [5].

25 The risk of transportation of infested host fruits is very high because *A. fraterculus*
26 and *A. grandis* produce in average 446 eggs [6] and 538 eggs per female [7], respectively.
27 One *A. grandis* female may oviposit up to 96 eggs per puncture [8]. Quarantine restrictions
28 are required for exportation of suitable hosts of both fruit fly species (Tephritidae). In the
29 case of *A. grandis*, exportation of cucurbits is allowed from crops managed in fruit fly-free
30 areas or under risk mitigation system.

31 Ground applications of insecticides under cover spray or toxic bait are the primary
32 methods for the control fruit flies in Brazil [9]. Organophosphates were used for five decades
33 against fruit flies in Brazil, especially malathion, dimethoate, ethion, phention and
34 trichlorfon. In earlier studies, *Anastrepha fraterculus* and *Ceratitis capitata* (Wied.) showed
35 high susceptibility to organophosphates, pyrethroids [10], spinosad [9] and neonicotinoids
36 [11] in laboratory.

37 Malathion is the most widely used insecticide against fruit flies around the world [12,
38 13, 14, 15, 16, 17], under both systems cover spray or toxic bait.

39 Flupyradifurone is the first representative of the novel butenolide class of insecticides,
40 active against various insect pests, with excellent safety profile. Flupyradifurone acts
41 reversibly as an agonist on insect nicotinic acetylcholine receptors but is structurally different
42 from known agonists (e.g. neonicotinoids). This insecticide exhibits excellent field efficacy
43 on several crops with different application methods, including foliar, soil, seed treatment and
44 drip irrigation [18].

45 There is no report on field fruit fly populations resistant or multi-resistant to
46 insecticides in Brazil. However, recently, several organophosphates were banned in our
47 country and growers demand new active ingredients for use as adulticide for fruit flies. The
48 aim of this study was to determine under laboratory conditions, the susceptibility of adults of

49 *A. fraterculus* and *A. grandis* to some new insecticides, to provide fruit fly control options for
50 the growers.

51 2. MATERIALS AND METHODS

52 Adults of *A. fraterculus* and *A. grandis* were obtained from the colonies maintained at
53 Instituto Biológico, in Campinas, State of São Paulo (SP), Brazil, since 1993 and 2002,
54 respectively. Larvae of *Anastrepha fraterculus* were reared in papaya fruits [19] and *A.*
55 *grandis* reared in orange pumpkin (*Cucurbita maxima*). During larval development, the fruits
56 were kept into plastic boxes, with a layer of vermiculite until pupation. The boxes were kept
57 in a temperature controlled rearing room ($25^{\circ}\text{C} \pm 3^{\circ}\text{C}$). Three days before emergence, pupae
58 were sieved from the vermiculite. After emergence, the fruit flies were transferred to rearing
59 cages (1.00 m x 0.50 m x 0.50m) and received water and a mixture of sugar (49.1%),
60 brewer's yeast (24.5%), yeast extract (12.2%), wheat germ (12.2%) and Sustagen[®] (2.0%).

61 All tested chemicals are described on Table 1. Deltamethrin, imidacloprid,
62 acetamiprid are registered for use in some fruit and cucurbit crops, while malathion,
63 pyradifurone, zeta-cipemethrin and phosmet are registered for fruit crops in Brazil [20].

64 Five females and five males of 8-9d-old *A. fraterculus* and 10-20d *A. grandis* were
65 captured in glass tubes and closed with cotton. Prior to the spraying, the tubes were stored in
66 the refrigerator at about -15°C for 4 minutes, and the flies were transferred immediately to
67 glass Petri dishes (8.5 cm diameter).

68 Insecticide suspension (2 mL) was applied on the adult flies under a Potter spray
69 tower at 60.0 kPa. After the treatment, the flies were maintained, at room temperature ($25 \pm$
70 3°C) and ambient humidity ($50 \pm 10\%$), deprived of water and food. Evaluations of
71 survivorship were conducted at 30, 60, 90, 120, 150, 180, 240, 360 minutes and 21 h after
72 initial exposure. Irreversible knockdown followed by death of the adults was the criterion to
73 determine mortality [11].

Ten replicates were used for each treatment. Each dish corresponded to one replication per treatment. We performed ANOVA (The SAS System for Windows, version 9.2) using ranked data [21]. Three-factor ANOVA was used to compare the mortality of fruit flies. The LT_{50} (lethal time) values for each compound were estimated using Probit analysis (Polo PC).

3. RESULTS AND DISCUSSION

The mortality provided by insecticides did not differ significantly between fruit fly species (females + males) ($F = 1.360$; $df=0.58$; $P=0.448$) and sex ($F = 1.360$, $df = 3.74$; $P = 0.054$). Different mortality levels were obtained among the insecticides ($F = 9,360$; $df = 155.96$; $P < 0.001$). Interactions were observed between the compounds and fruit fly species ($F = 9.360$; $df = 2.26$; $P = 0.018$) and between evaluation periods and treatments ($F = 27.1080$; $df= 32.85$; $P < 0.001$).

Deltamethrin, malathion, zeta-cypermethrin were highly toxic to both species of *Anastrepha*, with 100% mortality in a period of up to 30 minutes after treatment (Tables 2 and 3).

In the case of *A. grandis*, high mortality (86%) was also obtained for thiamethoxam (Table 2). The mortalities of *A. grandis* males at 30 minutes were similar ($\geq 90\%$) for deltamethrin, malathion, thiamethoxam and zeta-cypermethrin. Males of *A. fraterculus* were more susceptible than those of *A. grandis* to imidacloprid and phosmet, with mortalities above 80%, do not differing from the mentioned pyrethroid and organophosphate insecticides (Table 2).

The number of dead fruit flies was increasing between the evaluations for each insecticide treatment ($F = 3.1080$; $df = 344.51$; $P < 0.001$). The levels of mortality of fruit flies were higher at 21 hours after exposure for most of insecticides (Table 2). Except for

98 flupyradifurone sprayed on males (1.6 ppm), no statistically differences in mortalities were
99 observed between the fruit fly species at 21 hours.

100 The number of dead females of *A. fraterculus* at 30 minutes was higher than that of *A.*
101 *grandis* for acetamiprid and imidacloprid (Table 2).

102 Considering the lethal times of the insecticides, *A. fraterculus* was more susceptible
103 than *A. grandis*, with lower LT_{50} values for imidacloprid (F and M), flupyradifurone 1.6 ppm
104 (F and M), acetamiprid (M) and phosmet (F) (Table 3).

105 In the case of thiamethoxam, there was a tendency opposite to the other insecticides
106 tested, with greater susceptibility (lower LT_{50}) in *A. grandis* compared to *A. fraterculus*, with
107 significant differences for both sexes (Table 3).

108 No significant differences in LT_{50} values were detected between males and females of
109 *A. fraterculus* and of *A. grandis* for all the evaluated insecticides (Table 3).

110 Flupyradifurone at its highest concentration (1.6 ppm) presented significantly lower
111 lethal times (LT_{50}) (2.76 to 77.0 min) than at its lowest concentration (0.5 ppm) (119.2 to
112 700.2 min) for the two fruit fly species (Table 3).

113 Flupyradifurone, imidacloprid and acetamiprid ($LT_{50}s \geq 48.9$ min) were not effective
114 against *A. grandis* up to 60 minutes after exposure (Fig. 1).

115 Thiamethoxam is registered for many horticultural crops in Brazil, including zucchini,
116 watermelon, melon and cucumber [20]. *Anastrepha grandis* is a quarantine pest for many
117 countries, with risk to spread to free areas and those under mitigation risk system of
118 American continent [5]. In some regions of the state of São Paulo, *A. grandis* infestation
119 cause significant yield losses in orange pumpkin (*Cucurbita maxima*) and Tetsukabuto hybrid
120 (*C. maxima* x *C. moschata*). Due to the long time duration of immature stages of *A. grandis*
121 [7], economic losses may also occur during post harvest period and commercialization. Thus,
122 the growers spray insecticides to kill adults to prevent oviposition in cucurbits.

Females and males of *A. fraterculus* were more susceptible to imidacloprid and thiamethoxam than *C. capitata* under cover spray in laboratory [11]. The resistance or susceptibility of populations of *Bactrocera cucurbitae* Coquillett (Tephritidae) to insecticides in China is variable according to the crop [22], especially due to different selection pressure and geographic regions. In laboratory, zeta-cypermethrin killed adults of *Rhagoletis indifferens* (Tephritidae) more quickly than malathion and spinetoram, causing up to 100% mortality 2 hours after exposure [23].

Deltamethrin, malathion and zeta-cypermethrin caused complete mortality for adults of both species within a very short period (< 30 min) after application. Similar results were obtained for organophosphates and pyrethroids against *A. fraterculus* and *C. capitata* in laboratory [10]. Deltamethrin and malathion are effective to prevent infestation of *B. cucurbitae* in bitter melon in India [24]. Insecticides should kill fruit flies up to 2 hours after exposure in order to prevent oviposition in the field [23].

Direct spray was also quicker in killing the fruit flies in comparison with topical and residual contact method [23]. Consequently, calibrate pesticide spray equipment is essential to ensure the best foliar coverage and insect body contact. Although many insecticides do not kill immediately the flies, they may cause insect drop to lower canopy or onto the ground, where the adults are exposed to predation by ants and spiders [25, 26].

4. CONCLUSION

Results from this study demonstrate the potential use of insecticides from different chemical groups to kill adults of two *Anastrepha* species of economic and quarantine importance. The use of cover spray insecticide to manage resident or immigrant population of *Anastrepha* may be effective when the spray equipment provides effective contact with the fly body.

148 **REFERENCES**

- 149 1. White IM, Elson-Harris MM. (Eds) Fruit flies of economic significance: their
150 identification and bionomics. CAB International: Wallingford, UK, 1994; 601pp.
- 151 2. Raga A, Souza-Filho MF. ; Machado RA; Sato ME, Siloto RC. Host ranges and
152 infestation indices of fruit flies (Tephritidae) and lance flies (Lonchaeidae) in São
153 Paulo State, Brazil. Fla. Entomol. 2011; 94(4): 787-794.
- 154 3. Raga A, Paula L, Souza-Filho M, Castro, J. Population Dynamics and Infestation Rate
155 of Fruit Flies in Stone Fruits in São Paulo State, Brazil. An. Res. Rev. Biol. 2017; 14:
156 1-11.
- 157 4. Zucchi R A, Fruit flies in Brazil - *Anastrepha* species their host plants and parasitoids.
158 2008. Available: <http://lea.esalq.usp.br/anastrepha> (Accessed 25 May 2108).
- 159 5. Baldo FB, Berton LHC, Gislotti LJ, Raga A. New records of *Anastrepha grandis*
160 (Diptera, Tephritidae) and *Neosilba zadolicha* (Diptera, Lonchaeidae) in
161 Cucurbitaceae species in Brazil. J. Agr. Ecol. Res. Int. 2017; 13(2): 1-7.
- 162 6. Salles LAB. Biologia e ciclo de vida de *Anastrepha fraterculus* (Wied.), p. 81-86. In:
163 Malavasi A, Zucchi R A (Eds.). Moscas-das-frutas de importância econômica no
164 Brasil: conhecimento básico e aplicado. Ribeirão Preto, Holos Editora, Ribeirão Preto,
165 SP, 2000; 327 p.
- 166 7. Bolzan A, Nava DE, Garcia FRM, Valgas RA, Smaniotto G. Biology of *Anastrepha*
167 *grandis* (Diptera: Tephritidae) in different cucurbits. J. Econ. Entomol. 2015; 108(3):
168 1034–1039.
- 169 8. Raga A, Baldo FB. Ataque direto. Rev. Cultivar 2106; 99: 14-17.
- 170 9. Raga A, Sato ME. Effect of spinosad bait against *Ceratitis capitata* (Wied.) and
171 *Anastrepha fraterculus* (Wied.) (Diptera: Tephritidae) in laboratory. Neotrop.
172 Entomol 2005; 34(5): 815-822.

- 173 10. Raga A, Sato, ME. Time-mortality for fruit flies (Diptera: Tephritidae) exposed to
174 insecticides in laboratory. Arq. Inst. Biol. 2006; 73(1): 73-77.
- 175 11. Raga A, Sato ME. Toxicity of neonicotinoids to *Ceratitis capitata* and *Anastrepha*
176 *fraterculus* (Diptera: Tephritidae). J. Plant Prot. Res. 2011; 51(4): 413-419.
- 177 12. Zwick R W, Jones S C, Peifer F W, Every R W, Smith R L, Thienes J R. Malathion
178 ULV aerial applications for Cherry fruit fly control. J. Econ. Entomol. 1970; 63(5):
179 1693-1695.
- 180 13. Roessler Y. Insecticidal bait and cover spray. In: Robinson AS, Hooper G (Eds.).
181 Fruit flies: their biology, natural enemies and control, Elsevier, 1989. v. 3B, p. 329-
182 335.
- 183 14. Magaña C, Hernández-Crespo P, Ortego F, Castañera P. Resistance to malathion in
184 field populations of *Ceratitis capitata*. J. Econ. Entomol. 2007; 100(6): 1836-1843.
- 185 15. El-Aw MAM, Draz KAA, Hashem AG, El-Gendy IR. Mortality comparison among
186 spinosad-, Actara-, malathion-, and methomyl containing baits against Peach fruit fly,
187 *Bactrocera zonata* Saunders (Diptera: Tephritidae) under laboratory conditions. J. Ap.
188 Sci. Res. 2008; 4(2): 216-223.
- 189 16. Urbaneja A, Chueca P, Montón H, Pascual-Ruiz S, Dembilio O, Vanaclocha P, Abad-
190 Moyano R, Pina T, Castañera P. Chemical alternatives to malathion for controlling
191 *Ceratitis capitata* (Diptera: Tephritidae), and their side effects on natural enemies in
192 Spanish citrus orchards. J. Econ. Entomol. 2009; 102(1): 144-151.
- 193 17. Yaqoob R, Tahir HM, Naseem S, Ahmed K, Yaqub A. Susceptibility of *Bactrocera*
194 *dorsalis* (Diptera: Tephritidae) to commonly used chemical insecticides. Pakistan J.
195 Zool. 2015; 47(1): 280-282.

- 196 18. Nauen R, Jeschke P, Velten R, Beck ME, Ebbinghaus-Kintscher U, Thielert W,
197 Wölfel K, Haas M, Kunz K, Raupach G. Flupyradifurone: a brief profile of a new
198 butenolide insecticide. Pest Manag. Sci. 2015; 71(6): 850-862.
- 199 19. Raga A, Yasuoka ST, Amorim EO, Sato ME, Suplicy Filho N, Faria JT. Sensibilidade
200 de ovos de *Ceratitis capitata* (Wied., 1824) irradiados em dieta artificial e em frutos
201 de manga (*Mangifera indica* L.). Sci. Agri. 1996; 53(1): 114-118.
- 202 20. MAPA, 2018. Agrofit – Sistema de Agrotóxicos Fitossanitários. Available:
203 http://agrofit.agricultura.gov.br/agrofit_cons/principal_agrofit_cons. (Accessed 01 Jun
204 2018).
- 205 21. Conover W J, Iman R L. Rank transformation as a bridge between parametric and
206 nonparametric statistics. Amer. Statist. 1981; 35(3): 124-129.
- 207 22. Jin T, Lin Y, Jin Q, Wen H, Pen Z. Population susceptibility to insecticides and the
208 development of resistance in *Bactrocera cucurbitae* (Diptera: Tephritidae). J. Econ.
209 Entomol. 2016; 109(2): 837-846.
- 210 23. Yee WL, Alston DG. Behavioral responses, rate of mortality, and oviposition of
211 western cherry fruit fly exposed to malathion, zeta-cypermethrin, and spinetoram. J
212 Pest Sci. 2012; 85:141–151.
- 213 24. Sunil, Thippaiah M, Jagadish KS, Chakravarthy K. Efficacy of insecticides against
214 melon fruit fly *Bactrocera cucurbitae* (Coquillett) in bitter gourd. Entomon 2016;
215 41(3): 233-238.
- 216 25. Wong MA, Wong TTY. Predation of the Mediterranean fruit fly and the Oriental Fruit
217 fly (Diptera: Tephritidae) by the fire ant (Hymenoptera: Formicidae) in Hawaii. Proc.
218 Hawaii. Entomol. Soc. 1988; 28: 169–177.
- 219 26. Stibick JNL. Natural enemies of true fruit flies (Tephritidae). U.S. Department of
220 Agriculture. APHIS. Plant Protection and Quarantine, Riverdale, MD. 2004. p. 86.

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Table 1. Insecticides tested against fruit flies in laboratory

Chemical group	Chemical name	Trade name	Concn (ppm)
Neonicotinoids	acetamiprid	Mospilan WG	0.725
Pyrethroids	deltamethrin	Decis 25 EC	1.00
Butenolide	flupyradifurone	Sivanto Prime 200 SL	0.50
Butenolide	flupyradifurone	Sivanto Prime 200 SL	1.60
Neonicotinoids	imidacloprid	Evidence 700 WG	2.10
Organophosphates	malathion	Malathion 1000 EC	15.0
Organophosphates	phosmet	Imidan 500WP	7.50
Neonicotinoids	thiamethoxam	Actara 25 WG	0.50
Pyrethroids	zeta-cypermethrin	Mustang 350 EC	0.35

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Table 2. Comparison of adult mortality (number of dead insects per dish, $n = 5$) of *Anastrepha fraterculus* (AF) and *Anastrepha grandis* (AG) in two periods after exposure to insecticides under cover spray in laboratory.

Treatment	30 min		21 h	
	AF	AG	AF	AG
Females				
Acetamiprid 0.725 ppm	3.70bcA	0.10cB	5.00aA	5.00aA
Deltamethrin 1.00 ppm	5.00aA	5.00aA	5.00aA	5.00aA
Flupyradifurone 0.5 ppm	1.00cdA	1.00cA	2.80bA	2.80bA
Flupyradifurone 1.6 ppm	2.20cdA	0.20cB	4.10aA	5.00aA
Imidacloprid 2.1 ppm	3.70bA	1.40cA	5.00aA	5.00aA
Malathion 15.0 ppm	5.00aA	5.00aA	5.00aA	5.00aA
Phosmet 7.5 ppm	4.30bA	3.40bA	5.00aA	5.00aA
Thiamethoxam 2.10 ppm	1.60cdB	4.30abA	4.70aA	5.00aA
Zeta-cypermethrin 0.35 ppm	5.00aA	5.00aA	5.00aA	5.00aA
Control	0.00dA	0.00cA	0.10bA	0.00cA
Males				
Acetamiprid 0.725 ppm	4.50aA	0.30cB	5.00aA	5.00aA
Deltamethrin 1.00 ppm	5.00aA	5.00aA	5.00aA	5.00aA
Flupyradifurone 0.5 ppm	0.90cdA	0.90bcA	2.60cA	2.60bA
Flupyradifurone 1.6 ppm	3.10bcA	0.20cB	4.10bcB	5.00aA
Imidacloprid 2.1 ppm	4.10abA	1.10bcB	5.00aA	5.00aA
Malathion 15.0 ppm	5.00aA	5.00aA	5.00aA	5.00aA
Phosmet 7.5 ppm	4.30abA	2.50bB	5.00aA	5.00aA
Thiamethoxam 2.10 ppm	1.80cdB	4.50aA	4.90abA	5.00aA
Zeta-cypermethrin 0.35 ppm	5.00aA	5.00aA	5.00aA	5.00aA
Control	0.00dA	0.00cA	0.30dA	0.00cA

Means within columns followed by the same lower case letter are not significantly different (ANOVA – Tukey's test, $P < 0.05$). Means within rows followed by the same upper case letter in each time are not significantly different (ANOVA – Tukey's test, $P < 0.05$).

231 **Table 3. Comparison of lethal times (LT₅₀) obtained for both sex of *Anastrepha fraterculus* (Af)**
 232 **and *Anastrepha grandis* (Ag) exposed to insecticides under cover spray in laboratory.**

Treatment	Species	Sex	LT ₅₀ (min)	Slope ± SE	X ²	df
Acetamiprid 0.725 ppm	Af	Females	15.1 (5.95 – 24.5)	1.65 ± 0.29	0.71	7
	Ag	Females	52.0 (1.69 – 77.1)	3.69 ± 1.27	2.36	6
	Af	Males	8.02 (1.06 – 16.6)	1.84 ± 0.46	0.06	7
	Ag	Males	52.3 (47.8 – 56.8)	6.91 ± 0.63	0.49	7
Deltamethrin 1.00 ppm	Af	Females	< 30.0*	-	-	-
	Ag	Females	< 30.0*	-	-	-
	Af	Males	< 30.0*	-	-	-
	Ag	Males	< 30.0*	-	-	-
Flupyradifurone 0.5 ppm	Af	Females	516.5 (293.6 – 1850.7)	0.56 ± 0.14	0.71	7
	Ag	Females	145.3 (94.4 – 219.1)	0.70 ± 0.14	3.54	7
	Af	Males	700.2 (348.3 – 5093.5)	0.48 ± 0.14	1.96	7
	Ag	Males	119.2 (78.9 – 168.3)	0.80 ± 0.14	2.90	7
Flupyradifurone 1.6 ppm	Af	Females	2.76 (0.00056 – 14.7)	0.45 ± 0.16	2.91	7
	Ag	Females	77.0 (67.7 – 86.1)	3.31 ± 0.30	1.93	7
	Af	Males	6.55 (0.000001 – 22.6)	0.74 ± 0.35	0.21	3
	Ag	Males	69.7 (61.6 – 77.4)	3.86 ± 0.35	1.68	7
Imidacloprid 2.1 ppm	Af	Females	22.7 (14.8 – 28.3)	3.90 ± 0.76	0.34	7
	Ag	Females	48.9 (29.5 – 65.5)	4.84 ± 1.15	13.9	7
	Af	Males	13.7 (5.02 – 21.7)	2.26 ± 0.46	0.072	7
	Ag	Males	53.8 (36.9 – 68.7)	5.17 ± 1.07	13.8	7
Malathion 15.0 ppm	Af	Females	< 30.0*	-	-	-
	Ag	Females	< 30.0*	-	-	-
	Af	Males	< 30.0*	-	-	-
	Ag	Males	< 30.0*	-	-	-
Phosmet 7.5 ppm	Af	Females	3.70 (0.065 – 11.7)	1.28 ± 0.37	0.092	7
	Ag	Females	24.0 (16.6 – 28.9)	4.70 ± 1.02	0.014	7
	Af	Males	≤ 30.0	-	-	-
	Ag	Males	29.7 (23.3 – 35.0)	4.01 ± 0.58	0.025	7
Thiamethoxam 2.10 ppm	Af	Females	57.6 (25.6 – 85.2)	1.95 ± 0.41	2.73	7
	Ag	Females	6.31 (0.55 – 14.9)	1.53 ± 0.39	0.04	7
	Af	Males	37.4 (15.6 – 56.0)	1.95 ± 0.37	1.61	7
	Ag	Males	1.57 (0.00058 – 8.25)	0.98 ± 0.32	0.038	7
Zeta- cypermethrin 0.35 ppm	Af	Females	< 30.0*	-	-	-
	Ag	Females	< 30.0*	-	-	-
	Af	Males	< 30.0*	-	-	-
	Ag	Males	< 30.0*	-	-	-

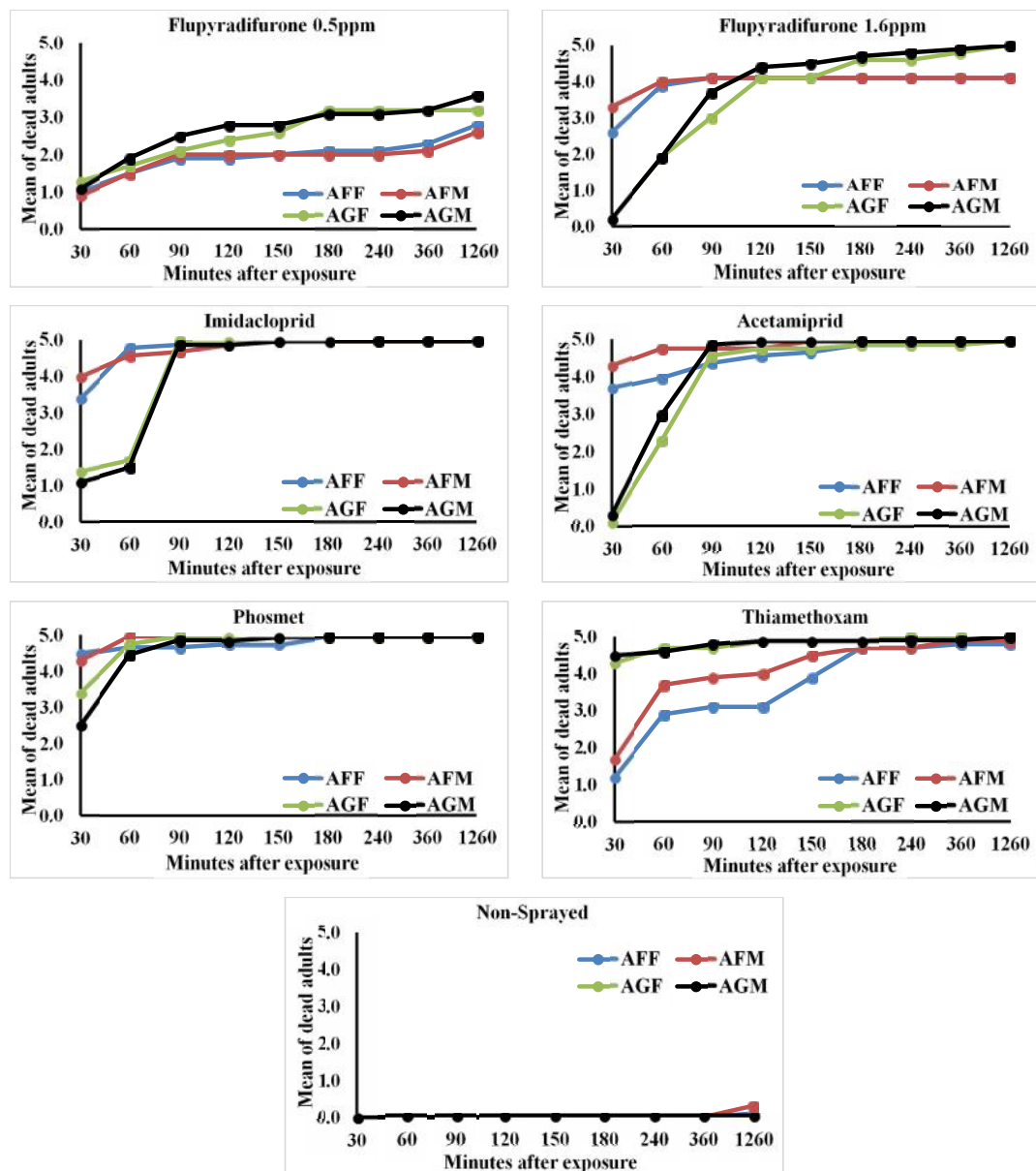


Fig. 1. Cumulative time-mortality curves for females (F) and males (M) of *Anastrepha fraterculus* (AF) and *Anastrepha grandis* (AG) exposed to insecticides that did not cause total mortality up to 30 minutes of exposure in laboratory.