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Attractive solutions efficiency in capturing *Zaprionus indianus* Gupta,1970 (Diptera: Drosophilidae) in *Ficus carica* L. (Moraceae) orchard in Santa Maria, Rio Grande do Sul, Brazil

Mauricio Paulo Batistella Pasini, Dionisio Link, Gabriel Schaich
Universidade Federal de Santa Maria, UFSM. Av. Roraima nº 1000, Cidade Universitária, Santa Maria, RS - Brasil.

Abstract

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This study aimed to determine the response of *Zaprionus indianus* Gupta, 1970 (Diptera: Drosophilidae) to different attractive solutions based on *Ficus carica* L., *Psidium guajava* L. and *Butia capitata* (Mart) Becc. juice diluted in water. The work was conducted at the Fruit Trees Sector from the Colégio Politécnico of the Universidade Federal de Santa Maria, Brazil, from February 25th to April 24th of 2010 in an orchard of fig. Plastic bottles were used as traps, and as attractants, were used pure *F. carica*, *P. guajava* and *B. capitata* juice and *F. carica* juice with a glucose solution, all diluted in water, amounting 200 ml of attractive solution for each bottle. Statistical analysis showed that *F. carica* juice diluted in water in the concentration of 50 % had the highest catch rates when compared with the other treatments and is recommended for controlling and monitoring *Z. indianus*. The rest of the attractants can be used as an alternative for monitoring. The highest catch levels are not associated with production peaks from the fig orchard. In the different attractants used, the pH, Brix degree and volume values correlated negatively with the number of fig fly adults captured.

Additional key words: alternative control, food baits, *Zaprionus indianus*.

Resumen

Pasini MPB, Link D, Schaich G. 2011. Eficiencia de soluciones atractivas en la captura de *Zaprionus indianus* Gupta, 1970 (Diptera: Drosophilidae) en un huerto de *Ficus carica* L. (Moraceae) en Santa Maria, Rio Grande do Sul, Brasil. Entomotropica 26(3): 107-116.

El estudio tuvo como objetivo determinar la respuesta de *Zaprionus indianus* Gupta, 1970 (Diptera: Drosophilidae) en diferentes soluciones atrayentes a partir de jugo de *Ficus carica* L., *Psidium guajava* L. y *Butia capitata* (Mart) Becc. diluidos en agua. Se realizó en el Departamento de Horticultura del Colegio Politécnico de la Universidad Federal de Santa María, desde el 25 de febrero al 24 de abril, 2010 en un huerto de *F. carica*. Como trampas se usaron frascos de plástico. Como cebos alimenticios se utilizó jugo de *F. carica*, *F. carica* y solución de glucosa, *P. guajava* y *B. capitata*, diluidos en agua, usándose por trampa 200 ml del atrayente. El análisis estadístico indica que el jugo de *F. carica* y agua a una concentración del 50% mostraron los mayores índices de capturas en comparación con otros tratamientos y se recomienda para el control y seguimiento de *Z. indianus*. El resto puede ser utilizado como alternativa a la supervisión. Los mayores niveles de captura no están asociados con el pico de producción de *F. carica*. En las diferentes soluciones utilizados, el pH, °Brix y el volumen se correlacionan negativamente con el número de *Z. indianus* capturados.

Palabras clave adicionales: cebos alimenticios, control alternativo, *Zaprionus indianus*.

Introduction

Zaprionus indianus Gupta, 1970 (Diptera: Drosophilidae) is a polyphagous drosophilid of tropical origin. Its first finding in Brazil was in persimmon fruits in Valinhos, a region of the state of São Paulo (SP) in 1999, (Vilela 1999, Vilela et al. 2000, Gallo et al. 2002, Stein et al. 2003). *Z. indianus* encountered favorable conditions for its development, adapting and spreading rapidly throughout Brazil (Vilela et al. 2000). In Santa Catarina (SC) the fly was found in 2001 (De Toni et al. 2002), in Rio Grande do Sul (RS) in 2000 (Silva et al. 2005). In the Americas there are also reports of the fig fly in Uruguay, Argentina, Panama and United States (Goñi et al. 2001, Lavagnino et al. 2008, Van Der Linde et al. 2006).

One of the probable causes related to introduction of species is the intensification of the global trade of fruits, lack of phytosanitary barriers and ignorance of the biotic potential of the individuals (Vilela et al. 2000). The morphology and biological characteristics of the fig fly may vary according to geographical changes (latitude, longitude and altitude) (Karam et al. 2000, Setta and Careto 2005). In the warmer months of the year the insect represents up to 80 % of the collected individuals in decomposing fruits (Silva et al. 2005). Due to the introduction of the fly in the region of Valinhos, about 50 % of fig production was lost, and the exportations decreased by 80 % (Vilela et al. 2000, Stein et al. 2003).

The feeding habits of *Zaprionus indianus* foster the multiplication of bacteria and yeasts that in turn rot the fruits. The rotting substrate is typically used by adults as a place for feeding, mating and oviposition; the larvae uses this substrate for its development (Vilela et al. 2000). The yeast *Candida tropicalis* is associated with figs infected by *Z. indianus* (Gomes et al. 2003), attracting adults for feeding, reproduction and oviposition (Raga and Souza Filho 2003).

Z. indianus needs an average of 13 to 20 days to complete its immature stage, corresponding one day and a half to egg, 8 to 13 days to larva, and four to nine days to pupa, varying according to the environmental conditions and nutrition. Longevity of mated adults, with and without supplemental feeding, is 24 to 83 days, and 21 to 91 days, respectively; and the average number of emerged adults is 255.93 and 69.08 respectively (Stein et al. 2003). Estimates from thermal requirements, determined the number of generations of *Z. indianus* for the main fig producing regions of Brazil, resulting in about 16.6, 12.4 and 12.7 generations per year in Valinhos (SP), Pelotas (RS) and São Sebastião do Paraíso (MG), respectively (Nava et al. 2007).

The fly attacks the figs at the beginning of maturation, making them commercially unusable. The eggs are laid on the bracts surrounding the ostiole in intact figs (in early maturity, phase when the fruits are harvested for export). Chemical control at this point may result in a significant increase in production costs, making the figs exportation unviable (Vilela et al. 2000).

Raga and Souza Filho (2003) obtained 99.8 % of *Z. indianus* adults from the total insects collected using attractant solutions containing molasses with fig in a fig orchard. Raga et al. (2006) in a citrus orchard, found a greater representation of fly catches with attractants containing molasses alone and molasses with orange juice.

Ficus carica L. cv. “Roxo de Valinhos” is well accepted for fresh consumption, being the most popular commercially cultivated variety (Simão 1998). This variety presents an open ostiole and easily develops cracks, that favor the attack of diseases and pests (Franco and Penteado 1986) such as *Z. indianus*.

The use of attractive baits is an alternative to minimize the effect of *Z. indianus* in fig orchards, hence knowing the attractiveness of different

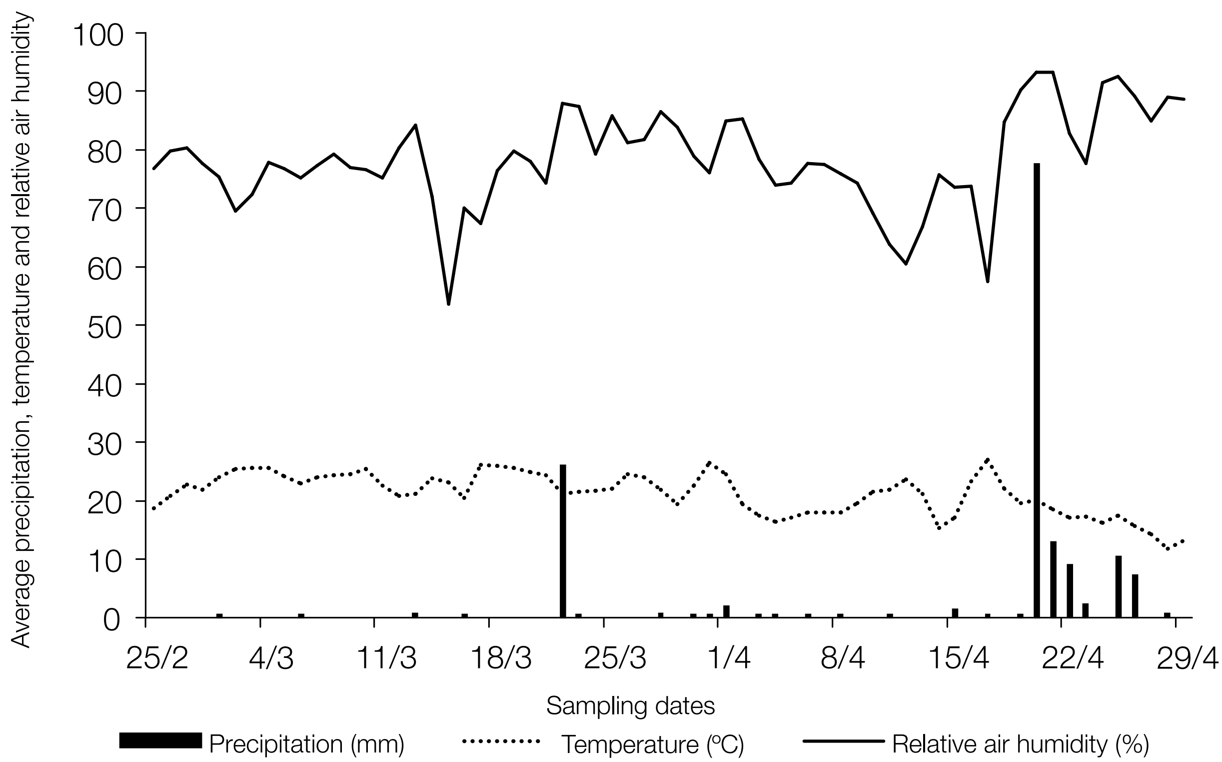

Figure 1. Average temperatures (°C), relative air humidities (%) and precipitation (mm), from the period of February 25th to April 29th of 2010, in Santa Maria, Rio Grande do Sul, Brazil (Source: INMET).

solutions is fundamental to control this insect. This study aimed to determine the response of the fig fly to different attractant solutions based on fig, guava and jelly palm juice, and fig juice with glucose, all diluted in water.

Materials and methods

The present work was conducted at the experimental plots of the Horticulture Department of Colégio Politécnico, Universidade Federal de Santa Maria (UFSM) - RS, at a latitude of 29º 43' South, a longitude of 53º 43' West, and an altitude around 96 m. According to Köppen's classification, the climate is a Cfa (humid temperate climate with hot summer) (Buriol et al. 1979).

The experiment was carried out from February 25th to April 24th of 2010, in a fig orchard with the cv. "Roxo de Valinhos" (Ficus carica L.) in its sixth year of production, planting grid of 2.5 m between rows and 2.0 m between plants. There was no insecticide application during the time of this research. Climatological data for the corresponding period were collected from the UFSM meteorological station and plotted accordingly (Figure 1).

Fly traps consisted of plastic bottles with a total volume of 600 mL, with two holes of eight millimeters diameter. Traps were attached to the fig tree branches with a 30 cm long nylon line. As attractive baits pure fig, guava (*Psidium guajava* L.) and jelly palm [*Butia capitata* (Mart) Becc.] juice diluted in water were used, as well as a mix of fig juice with glucose, diluted in water up to a final volume of 200 ml of attractive solution per bottle.

The experiment consisted in eight treatments in a randomized block design with four replications, totaling 32 plots with one plant

Table 1. Treatments types used in cv. "Roxo de Valinhos" fig orchard's to capture of *Zaprionus indianus*.

Code	Volume (mL)					Total/traps (mL)
	Fig Juice	Jelly Palm Juice	Guava Juice	Glucose	Water	
F1	100				100	200
F2	80				120	200
FG1	70			30	100	200
FG2	50			50	100	200
JP1		50			150	200
JP2		70			130	200
G1			50		150	200
G2			70		130	200

F: Fig; FG: Fig and Glucose; JP: Jelly Palm; G: Guava

per plot (Table 1). The bottles with attractive solutions were placed randomly throughout the orchard, at mid height of each plant and with indirect sun light, positioned on the west side of the plant canopy. The attractive solutions were placed on February 25th, replaced on March 25th and removed from the orchard on April 29th, corresponding to the permanence of 28 and 35 days, respectively.

Weekly samples were taken using a sieve to separate the insects from the solution, which was reattached to the trap after removing the specimens. The individuals were taken to the laboratory for separation, identification (Vilela et al. 2000) and analysis. Vouchers of the best preserved representative specimens were kept and dry mounted.

For standardization and conservation purposes the juices used as base for attractive solutions had the Brix degree (°Brix) increased to 50º and then frozen. Thawing of the solutions was done on February 24th and March 24th, the same day of their use in the field. The variations of volume, °Brix and pH, were measured weekly with a beaker cup, a refractometer (range from 0 to 32° and 0 to 80°) and a digital pH meter, respectively. The production data from the fig orchard and from the guava orchard next to the experiment were recorded weekly following standard criteria of harvest.

Values obtained were organized and an analysis of variance, ANOVA, separation of means (Tukey at 5 %), correlation and regression were performed using the software Microsoft ExcelTM 2007.

Results

In the nine weeks, 14,620 adult individuals representing two insect Orders were captured, namely Coleoptera 7.64 % and Diptera 92.35 %. Drosophilidae (Diptera) with 74.29 % of total adults was the dominant family, and *Z. indianus* with 50.98 % of the total adults the predominant species (representing respectively 55.21 % of the Diptera and 68.63 % of the Drosophilidae).

Treatment percentages of adult *Zaprionus indianus* captured are as follows: F1 22 %; F2 18 % ; FG1 11 %, ; FG2 14 % ; JP1 11 %; JP2 12 %; G1 6 % and G2 6 % (Figure 2).

In the first 28 day period, F1 yielded an average of 141.50 individuals, differing statistically from the attractants based on guava juice G1 and G2

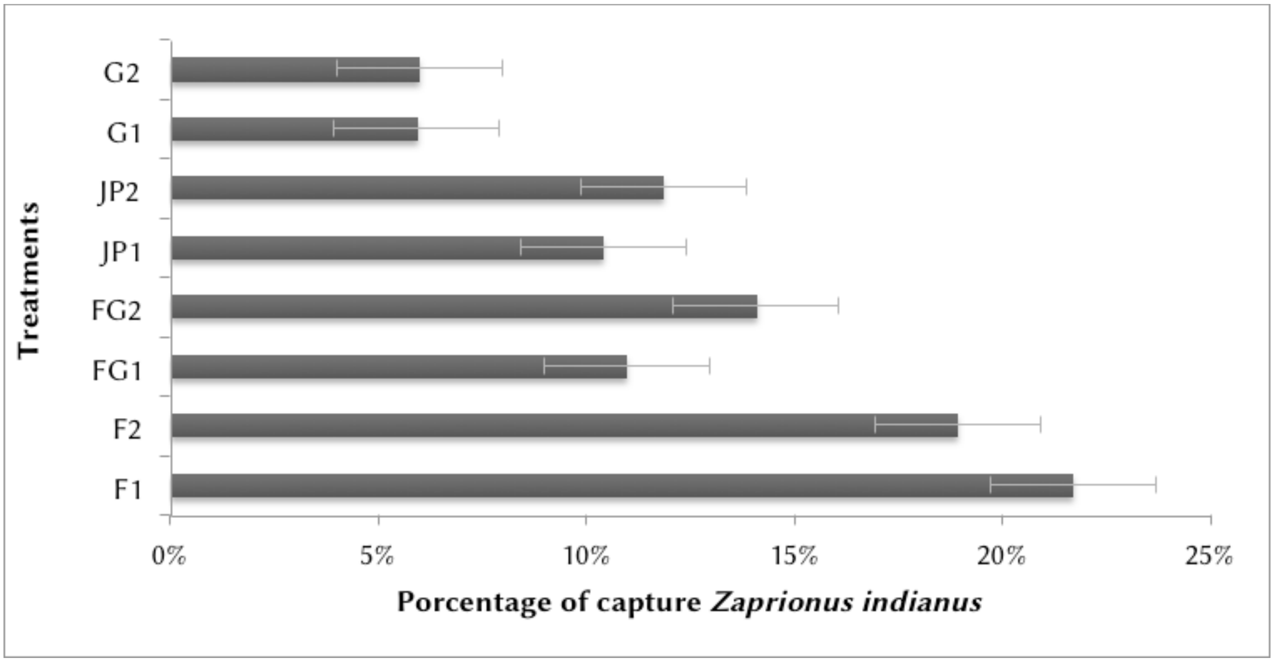

Figure 2. Percentages of individuals captured by treatments in nine weeks in Santa Maria County, Rio Grande do Sul state, Brazil, 2010.

(Table 2). With the placement of a fresh solution (second period) the average catch increased in all treatments, however it differs statistically from the first analysis. F1 yielded an average of 267.25 captures, and F2 226.25. Guava juice treatments showed low captures. FG1, FG2, JP1 and JP2 presented intermediary values.

In the experiment, F1 showed the highest values of captures per week with an average of 45.4 (±21.3), followed by F2, FG2, JP2, FG1, JP1, G1 and G2 with the smallest average value per week of 12.4 (±6.7). The capture peak of F1 is found at the sixth week, which corresponds to the capture peak of *Z. indianus*, it differs statistically from the first, second and ninth weeks, other weeks showed lesser values and did not differ statistically. Capture peak showed an average of 73.8 (±15.9) captures. The lowest values were obtained in the first week of sampling 10.0 (±3.1) (Table 3).

F2 showed the greatest levels from the sixth to the eighth week, these were only statistically different from the first week. In FG1, there was no significant difference, but the highest average values were obtained in the seventh week. FG2 showed no statistical difference, the capture peak corresponding with FG1. JP1 and JP2 obtained their highest levels of catch in the eighth week, amounting to an average of 52 (±23.2) and 45 (±18.7), respectively. The greatest levels for G1 and G2 were obtained in the fifth and sixth weeks, and the second showed no statistical difference between dates. In the experiment, the highest average of capture has been obtained in the eighth week, 40.2 (±22.2), the smaller corresponding to the first week, 5 (±4.46).

The average values for pH, °Brix and volume were correlated in positive ways with one another, with greater significance between °Brix and volume. These values correlated with the average weekly catch number have shown to be negative, with greater significance between °Brix and *Z. indianus* (-0.63) (Figure 3). The pH values associated with captures *Z. indianus* in most treatments were little significant

Table 2. Average efficiency of different solutions in eight weeks, in the capture of *Zaprionus indianus* adults, corresponding to two capture periods in Santa Maria county, Rio Grande do Sul state, Brazil. 2010.

Solutions	Period							
	1º(28 days[1])				2º(35 days[1])			
	Σ[a]	$\bar{x}$[b]	SD[c]	CV(%)[d]	Σ	$\bar{x}$	SD	CV(%)
F1	141.50	35.38 a*	23.00	65.02	267.25	53.45 a	18.20	34.05
F2	111.25	27.81 ab	20.02	71.98	226.25	45.25 ab	13.01	28.75
FG1	63.25	15.81 ab	11.05	69.86	143.50	28.70 bcd	16.83	58.63
FG2	85.50	21.38 ab	20.03	93.70	180.00	36.00 bc	13.56	37.67
JP1	67.00	16.75 ab	19.90	118.82	129.25	25.85 cd	15.59	60.33
JP2	68.50	17.13 ab	16.15	94.29	155.25	31.05 bcd	12.70	40.90
G1	36.75	9.19 b	6.80	74.00	75.25	15.05 d	6.03	40.10
G2	32.25	8.06 b	4.25	52.77	80.75	16.15 d	9.06	56.10
	606.00	18.94	9.15	48.32	1257.50	31.44	13.29	42.29

[1] Period of permanence of the substrate in the traps. [a] Summatory, [b]Average, [c]Standard deviation, [d]Coefficient of variation. * Means followed by the same letter in the column do not differ statistically according to Tukey test at 5 %.

Table 3. Behavior and comparison of eight attractive solutions in nine weeks, related to the average number of *Zaprionus indianus* adults captured in a fig orchard, cv. "Roxo de Valinhos" in Santa Maria county, Rio Grande do Sul state, Brazil. 2010.

Attractive solutions	Collection date											
	4/3	11/3	18/3	25/3	1/4	8/4	15/4	22/4	29/4	x	SD	CV
F1	10.0 D*a**	22.3CDa	50.8 ABCa	58.5 ABa	49.0 ABCa	73.8 Aa	58.3 ABa	61.3 Aa	25.0 BCDa	45.4	21.3	47.0%
F2	6.0 Ba	21.0 ABa	53.8 ABa	30.5 ABa	40.8 ABab	55.8 Aab	54.5 Aab	50.8 Aab	24.5 ABa	37.5	17.9	47.7%
FG1	5.0 Aa	9.3 Aab	19.3 Aa	29.8 Aa	16.5 Ac	42.0 Aabc	45.5 Aab	33.3 Aab	6.3 Abc	23.0	15.3	66.5%
FG2	3.0 Ca	8.8 BCab	26.3 ABCa	47.5 ABa	28.5 ABCbc	41.3 ABCabc	51.8 Aab	41.8 ABCab	16.8 ABCabc	29.5	17.4	58.9%
JP1	3.5 Ba	3.3 Bb	14.8 ABa	45.5 ABa	10.8 ABc	24.0 ABCbc	24.0 ABab	52.0 Aab	18.5 ABab	21.8	17.1	78.5%
JP2	2.3 Ca	8.8 BCab	18.3 ABCa	39.3 ABa	17.5 ABCc	34.5 ABCbc	40.3 ABab	45.0 Aab	18.0 ABCab	24.9	15.2	61.3%
G1	3.5 Ba	6.3 ABb	8.0 ABa	19.0 ABa	21.0 Ac	12.3 ABc	16.8 ABb	19.3 ABb	6.0 ABbc	12.4	6.7	54.0%
G2	4.0 Aa	6.5 Ab	7.8 Aa	14.0 Aa	13.0 Ac	28.8 Abc	16.8 Ab	18.5 Ab	3.8 Ac	12.6	8.1	64.7%
a	4.7	10.8	24.8	35.5	24.6	39.0	38.5	40.2	14.8	25.9		
SD b	2.5	7.0	18.0	15.0	13.8	19.2	17.0	15.5	8.4	22.6		
CV c	0.5	0.7	0.7	0.4	0.6	0.5	0.4	0.4	0.6	0.9		

[a] Average; [b] Standard deviation; [c] Coefficient of variation. * Means followed by same letter in the columns do not differ statistically by the Tukey test at 5% significance. ** Means followed by the same letter in the lines do not differ statistically by the Tukey test at 5% significance.

representing almost no influence over their capture.

In F1 and F2 the average catch values of *Z. indianus* were negatively correlated with pH, °Brix and volume, the highest significance has been obtained between ºBrix and *Z. indianus* (-0.66 and -0.53 respectively). In the FG1, pH and ° Brix both correlated negatively with *Z. indianus*, presenting greater significance. Different results were obtained with FG2, where pH was positively correlated with *Z. indianus*, the correlation of this with °Brix showed the greatest significance between treatments (-0.69). In JP1 and JP2, we found weak negative correlations of pH, °Brix and volume with *Z. indianus*. In G1, the pH has been more significant when compared to *Z. indianus*, presenting negative correlation, in G2, the correlation was not significant. There was no significance in the correlation between the average number of adults caught with the values of average temperatures, relative air humidities and precipitation.

Discussion

The great attractiveness presented by F1 is related mainly to the food preference of *Z. indianus*, a fact not emphasized in previous work (Raga and Souza Filho 2003, Raga et al. 2006). F2 shows smaller efficiency in the capture of adults of *Z. indianus*, when compared with F1. This was due to the fact that it presents smaller amount of juice of figs in their formulation (Table 1). In the third week F2 obtained higher captures than F1, but this fits as an isolated fact in the different weeks of collection.

The lesser attractiveness of solutions FG1 and FG2 compared with F1 and F2, may be related to glucose and the low concentration of fig juice (Table 3). Fig juice with the addition of glucose was less efficiently and showed higher cost for its formulation, because the glucose purchase. It should only be used in cases where there is low availability of fruits (figs) for making the attractive solution, this fact usually occurs at the beginning of the harvest of figs.

The solutions based on jelly palm juice, obtained intermediary performance when compared with treatments on the basis of fig juice. JP2 with higher concentration of jelly palm juice, was more effective that JP1 in the two periods of collection (Table 2). Guava juice solutions presented the lowest catch levels among the treatments. Guava juice and jelly palm juice are considered secondary attractants, and their use is recommended for monitoring work, leaving it to the professional their employment.

During the period of permanence of the treatments in the orchard of F. carica, there was no record of attack by *Z. indianus* in healthy figs. Figs with anomalies and attacks by other pests, which expose the interior of the fig, leaves the fruit vulnerable to attack of *Z. indianus*, hence serving as attractors and dispersers. Our technique suggests to be useful not just to monitor but also to control this insect. When compared with the numbers obtained by Raga and Souza Filho (2003), the values from the present work are much lower, but the differences in the environment, period of capture, trap bottle model, number of holes per bottle and substrate used must be considered.

The highest catch levels were obtained from the second to the fourth week of April. Relating the average values of *Z. indianus* capture with the amount of figs harvested per plant, a positive but not significant correlation was found (Figure 4). The number of adults captured did not show to be influenced by the production of figs, with a low correlation between the treatments and the average production of figs in the orchard. The average production of guava orchard presented higher values of correlation when compared with average capture of *Z. indianus*, in all treatments the values obtained were higher than those achieved in fig orchard. This indicates a strong influence of external factors on the population of *Z. indianus* in the guava orchard.

The guava orchard without correct management of the crop residues, acts as a disseminator of *Z. indianus* (Figure 4). This situation is created by the conditions offered by rotting fruits, offering conditions for the development of immature forms and adult (Vilela et al. 2000; Lavagnino et al. 2008). Thus, comparative data associated with the production of guava can relate obeying one to two weeks, respecting the biology of the fly (Stein et al. 2003). These comparisons can be fit for the local situation, where the fig orchards are commonly close to the guava orchards, either in large or small areas.

Several factors may be related to the increase of *Z. indianus* capture in fig orchard: physical and chemical behavior of the solution such as pH, °Brix and volume are involved; these add

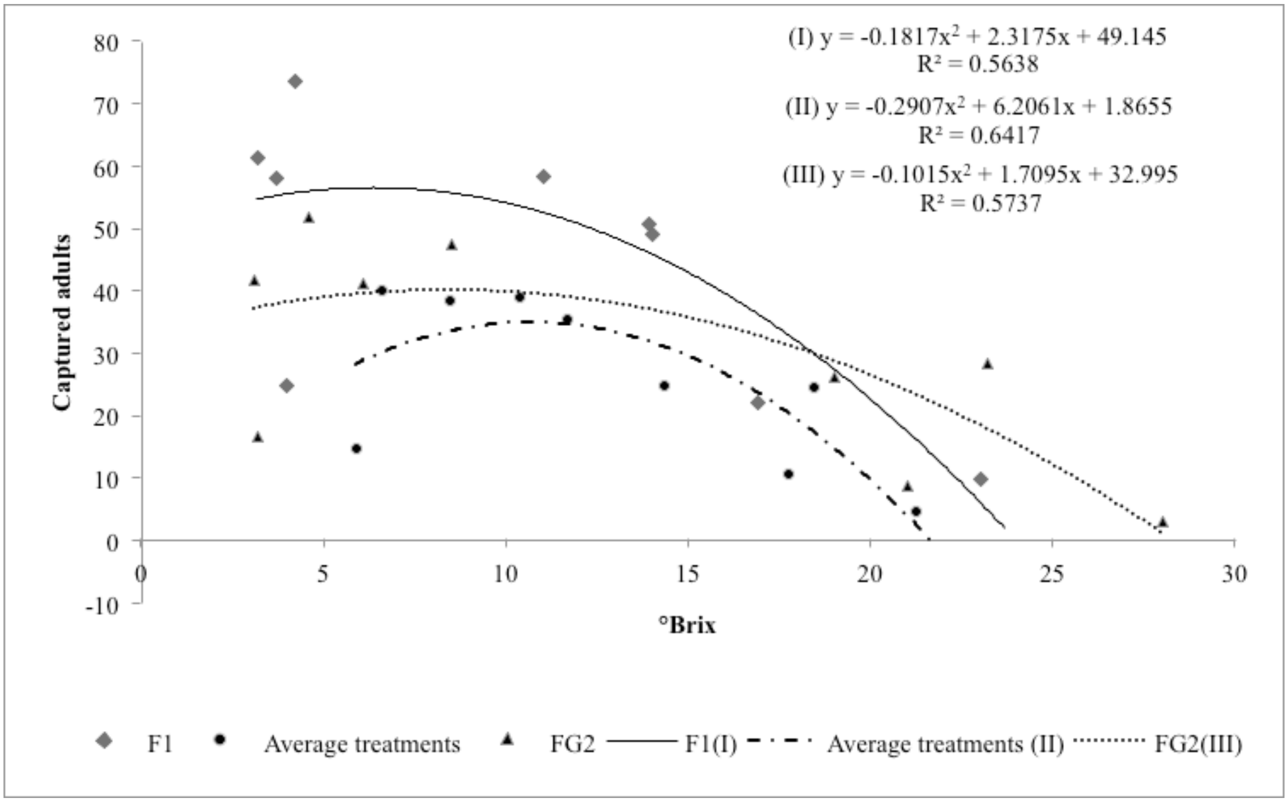

Figure 3. Effect of °Brix on the average number of captured *Zaprionus indianus*, in fig orchard cv. "Roxo de Valinhos. Santa Maria county, Rio Grande do Sul state, Brazil. 2010.

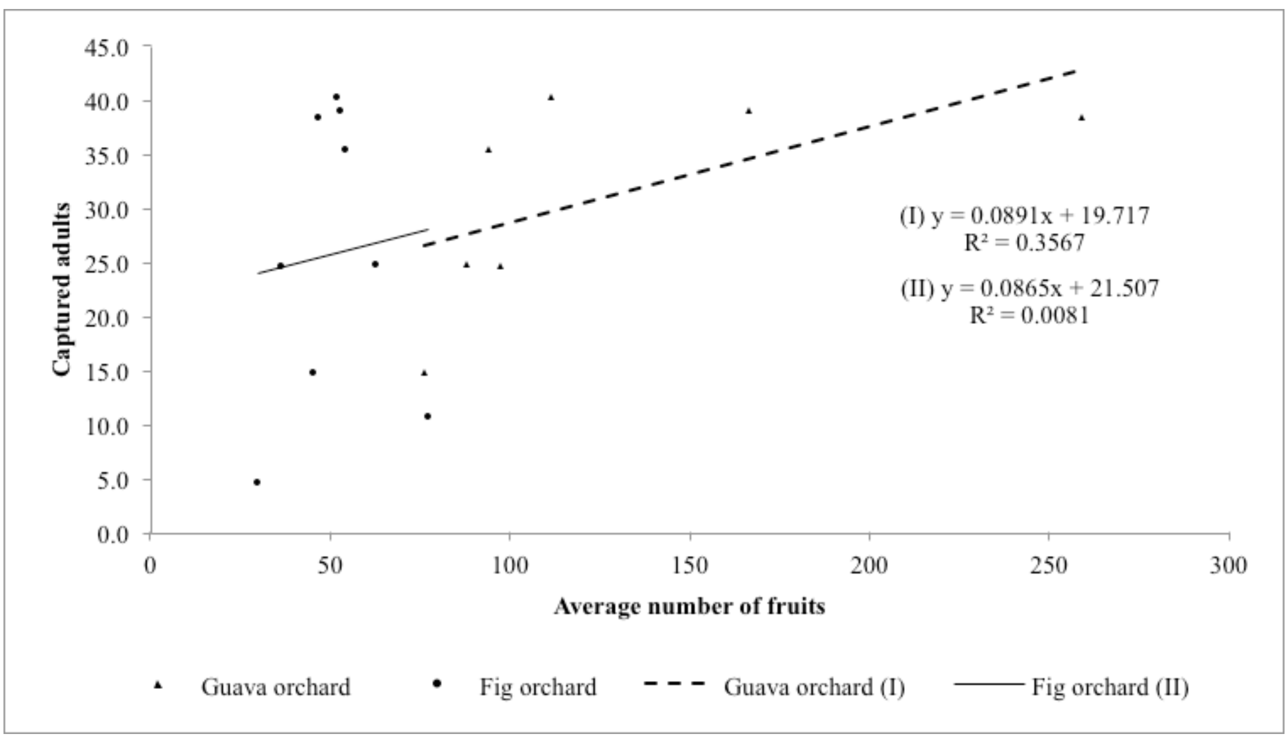

Figure 4. Average number of adults of *Zaprionus indianus* related to the average number of figs and guava harvested in each orchard, in Santa Maria county, Rio Grande do Sul state, Brazil. 2010.

themselves to others factors contributing to the capture, as environment, primarily facts related to climate, food supply, presence of ripe figs, hosts in the surroundings, position of the trap bottles relative to the plant, solar radiation and especially the type of substrate used in the trap bottles to catch adult flies.

Conclusion

The attractant based on fig juice diluted in water in a concentration of 50 % had the highest catch rates when compared with the other treatments, and is recommended for controlling and monitoring *Zaprionus indianus*.

The other solutions can be used as an alternative for monitoring but are not recommended for fig fly control. Attractive solutions based on jelly palm and guava juice are effective and cheap.

The highest catch levels are not associated with the peak production neither in fig or guava orchard.

Parameters like pH, °Brix and volume correlate negatively with the number of adults of fig fly captured.

References

Buriol GA, Estefanel V, Ferreira M, Saccol AV, Schneider FM, Heldwein AB. 1979. Cartas mensais e anuais das temperaturas medias, das medias das temperaturas maximas e das médias das temperaturas minimas do estado do RS. *Revista do Centro de Ciencias Rurais 9, suplemento, np*.

De Toni DC, Hofmann PRP, Valente VLS. 2002. First register of *Zaprionus indianus* (Diptera: Drosophilidae) in the state of Santa Catarina. *Biotemas* 14:71-85.

Franco LAM, Penteado SR. 1986. Cultura da figueira. In: Penteado SR, *Fruticultura de clima temperado em São Paulo*. Campinas, Fundação Cargill, p 113-129.

Gallo D, Nakano O, Silveira Neto S, Carvalho RPL, Baptista GC, Berti Filho E, Parra JRP, Zuchi RA, Alves, SB, Vendramim. 2002. *Manual de Entomologia Agrícola*. Piracicaba, FEALQ. 920p.

Gomes LH, Echeverrigaray S, Conti JH, Lourenço MVM, Duarte KRM. 2003. Presence of the yeast *Candida tropicalis* in figs infected by the fruit fly *Zaprionus indianus* (Dip.: Drosophilidae), *Brazilian Journal of Microbiology* 34: 5-7.

Goñi B, Fresia P, Calviño M, Ferreiro MJ, Valente VLS, Silva LB. 2001. First record of *Zaprionus indianus* Gupta, 1970 (Diptera: Drosophilidae) in southern localities of Uruguay. *Drosophila Information Service* 84: 61-65.

Karan D, Dubey S, Moretea UB, Parkash R, David JR. 2000. Geographical clines for quantitative traits in natural populations of a tropical drosophilid: *Zaprionus indianus*. *Genética* 108: 91–100.

Lavagnino NJ, Carreira VP, Menesch J, Hasson E, Fanara JJ. 2008. Geographic distribution and hosts of *Zaprionus indianus* (Diptera: Drosophilidae) in North-Eastern Argentina. *Revista de la Sociedad Entomológica Argentina* 67: 189-192.

Nava DE, Nascimento AM, Stein CP, Haddad ML, Bento JMS, Parra JPR. 2007. Biology, thermal requirements, and estimation of the number of generations of *Zaprionus indianus* (Diptera: Drosophilidae) for the main fig producing regions of Brazil. *Florida Entomologist* 90: 495-501.

Raga A, Machado RA, Dinardo W, Strikis PC. 2006. Eficacia de atrativos alimentares na captura de moscas-das-frutas em pomar de citros. *Bragantia* 65: 337-345.

Raga A, Souza Filho MF. 2003. Captura de *Zaprionus indianus* (Gupta) (Dip: Drosophilidae) em frascos de plastico com iscas alimentares na cultura do figo. *Revista de Agricultura, Piracicaba.* 78: 323-329.

Salles LAB. 1995. Bioecologia e controle da mosca-das-frutas sul-americana. Bol. Nº 1, EMBRAPA, CPATC, Pelotas. 25p..

Serrano LAL, Marinho CS, Lima IM, Martins MVV, Ronchi CP, Tardin FD. 2008. Fenologia da goiabeira 'paluma' sob diferentes sistemas de cultivos, epocas e intensidades de poda de frutificação. *Bragantia* 67: 701-712.

Setta N, Carareto CMA. 2005. Fitness components of a recently-established population of *Zaprionus indianus* (Diptera, Drosophilidae) in Brazil. *Iheringia Serie Zoologica* 95(1): 47-51.

Silva NM, Fantinel CC, Valente VL, Valiati VH, 2005. Ecology of colonizing of the fig fly *Zaprionus indianus* (Diptera, Drosophilidae) in Porto Alegre, Southern Brazil. *Iheringia, Serie Zoologica*, 95: 233-240.

Simão S. 1998. *Tratado de fruticultura*. Piracicaba, FEALQ. 760 p.

Stein CP, Teixeira EP, Novo JPS. 2003. Aspectos biologicos da mosca do figo, *Zaprionus indianus* Gupta, 1970 (Diptera: Drosophilidae). *Entomotropica* 18: 219-221.

van der Linde K, Steck GJ, Hibbard K, Birdsley JS, Alonso LM, Houle D. 2006. First records of *Zaprionus indianus* (Diptera: Drosophilidae), a pest species on commercial fruits from Panama and the United States of America. *Florida Entomologist* 89: 402-404.

Vilela CR, Teixeira EP, Stein CP. 2000. Mosca-Africana-do-figo, *Zaprionus indianus* (Diptera: Drosophilidae), In: Vilela EF, Zuchi RA & Cantor F (Eds.), Pragas Introduzidas no Brasil. Ribeirao Preto, Holos p. 48-52.

Vilela CR. 1999. Is *Zaprionus indianus* Gupta, 1970 (Diptera, Drosophilidae) currently colonizing the Neotropical Region? *Drosophila Information Service* 82:48-52.