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Full Length Research Paper

Efficiency of different traps to capture *Zaprionus indianus* (Diptera: Drosophilidae) in fig orchard in Santa Maria county, Rio Grande do Sul state, Brazil

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The use of food baits in traps is an alternative for monitoring and controlling of *Zaprionus indianus* (Diptera: Drosophilidae). The damages caused by the fig fly, in fig orchards in Brazil are expressive, however there are few alternatives to minimize their attack. The aim of this work was to determine the response of *Z. indianus* to different traps models. The trials were developed at the University Federal of Santa Maria in Santa Maria County, Rio Grande do Sul state, Brazil, from February 11 to April 1, 2010, in fig orchard (*Ficus carica* L.). The experimental design used was randomized block, with five treatments and four replications. Four different traps models were evaluated: pet colorless bottle of 2L capacity (P1); plastic bottle McPhail (M1), pet bottle of 1L, white (P2) and plastic bottle of 0,6L, this one was colorless (P3I) and one of green color (P3V). The best trap for capturing *Z. indianus* was P3I trap. Also traps P3V and P2 captured satisfactorily to *Z. indianus*, however, before using the last traps is necessary to perform an adjustment on them. The McPhail trap is inefficient in the research condition.

Keywords: Alternative control, drosophilidae, environment, fig fly, food baits.

INTRODUCTION

The *Zaprionus indianus* Gupta, 1970 (Diptera: Drosophilidae) is a polyphagous drosophilid of tropical origin. Its first recording in Brazil was from 1999 in fruits of *Diospyros kaki* L. (Vilela, 1999; Vilela et al*.,* 2000; Gallo et al*.,* 2002; Stein et al*.,* 2003). In Brazil, it has found favorable conditions for its development. Therefore, in short time has adapted and dispersed throughout the country (Vilela et al*.,* 2000). Also it has been recorded in several states, including Santa Catarina, Rio Grande do Sul and the Minas Gerais state (De toni et al., 2001; Silva et al., 2005; Linde et al., 2006). On the American continent record were also made in Uruguay, Argentina, Panama and the United States (Goñi et al., 2001; Linde et al., 2006; Lavagnino et al., 2008).

Z. indianus has a high biotic potential and a short life cycle, the morphology and biological characteristics diverge according to geographical location (for the latitude, longitude and altitude). Depending on weather conditions the number of generations per year can vary from 12 to 16 (Karan et al., 2000; Vilela et al., 2000; Setta and Carreto, 2005; Nava et al. 2007) and its biological cycle of 13 and 23 days (Stein et al. 2003). In the warmer months of the year, the 80% of individuals are collected of fruit in decomposition (Silva et al., 2005). The fly lays its eggs in the fig ostiole, after the larvae developed leaving the fruit unfit for consumption (Vilela et al., 2000).

The fig (*Ficus carica* L.) "Roxo de Valinhos" cultivar is well accepted for raw consumption, and the most commercially cultivated (Simão, 1998). This type of fig has an open ostiole and easily develops a crack that favors the attack of pests and diseases (Penteado, 1986). The chemical control may result in a significant increase in production costs, and reduce the fig export (Vilela et al*.,* 2000).

The search for an efficient system of monitoring is the basis for prevention and control of pests (Raga and

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Table 1. Relation of different trap models utilized, density and efficiency compared in fig orchard cv. "Roxo de Valinhos" in Santa Maria county, Rio Grande do Sul state, Brazil, 2010.

Trap model	Color	Code	AC[1]/day	A[2]/m²	A/plant
McPhail	----	M1	0.01	-	-
Bottle pet[3] 2L	Co[4]	P1	1.49	1.75	2.5
Bottle pet 1L	W[5]	P2	0.4	6.3	9
Bottle pet 0,5L	Co	P3I	3.65	0.7	1
Bottle pet 0,5L	Gr[6]	P3V	1.49	1.75	2.5

[1]AC: Adults captured, [2]A: Adults, [3]Pet: Tereftalad Polystyrene [4]Co: colorless, [5]W: White, [6]Gr: Green.

Souza Filho, 2003). The use of plastic fly traps of recycled materials of the, farm can be a low-cost and efficient alternative (Sales, 1995; Raga and Souza Filho, 2003). Levels of good capture acceptable have been obtained with Pet (polyethylene tereftalad) bottles (2L) and McPhail trap(Raga and Souza Filho, 2003; Raga et al*.,* 2006).

The use of attractive foods, is an alternative in the capture of *Z. indianus*, its efficiency is strictly related to the type of trap (Pasini et al., 2011). Efficient traps and economically viable are the basis in of pest control (Sales, 1995; Gallo et al., 2002). The objective of this work was to determine the response of *Z. indianus* to different traps models.

METHODS

The work was conducted at an experimental area located in the Orchard Sector of the Colégio Politécnico of Universidade Federal de Santa Maria (UFSM), in Santa Maria county, Rio Grande do Sul state, Brazil (29º43'S, 53º43'W). According to Köppen climate classification, it is Cfa (Humid temperate climate with hot summer) (Buriol et al., 1979).

The experiments was conducted from the 11 February to April 1, 2010, in the fig orchard "roxo de Valinhos" cultivar, in the sixth year of production. With distance between rows was 2.5m and between plants 2m. No insecticide was appliqued during the work execution. Data for average of temperatures, relative humidity and precipitation for the period were collected from a meteorological station of UFSM (29º43'S, 53º43'W).

The attractive solution used the base of fig juice diluted in the water, with 0.1L for each, totaling 0.2L in each trap (Pasini et al., 2011). To monitor and better evaluate the traps, proceeded weekly evaluation of the volumes in the different traps and determine its effect on the capture of *Z. indianus*. It was made using the graduated beaker measurement.

Four different traps models were evaluated: pet (polyethylene tereftalad) colorless bottle of 2L capacity (P1) (Raga and Souza Filho, 2003); plastic bottle McPhail (M1) (Raga et al., 2006); pet white bottle of 1L (P2) and plastic bottle of 0.6L, this colorless (P3I) and the green color (P3V) (Table 1). Two perforations of eight millimeters in diameter were made in the bottles for insects to entry (Figure 1). They were fixed in the fig tree by a nylon line, staying a 30cm distance from the branch on which was fixed and 30-50cm of soil level (Figure 1).

The experimental design was randomized block, with five treatments and four replications, 20 plots of total with one plant per plot, the density of one trap for every five square meters. The bottles with attractive solutions were placed randomly in the orchard in the middle part of each plant under indirect sun light, westward in relation to the plant canopy. The attractive solutions remained for two periods in the orchard, in the first of 21 days and the second of 28 days. In the first, attractive solution was placed on Feb. 11 and withdrawn on March 4, 2010, in the second, attractive solution was placed on March 4 and removed on April 1, 2010.

Samples were weekly collected, using a sieve to separate individuals from the syrup which was reinstated into the trap. The specimens were taken to the laboratory for screening, identification (Yassin and David, 2010) and analysis. In order to better monitor the efficiency of different trap models, we proceeded to follow the harvest, the plants with traps each week after the harvest; the fruits were analyzed to investigate the fig fly attack. Production of the orchard was obtained weekly from the average number of figs per plant.

The values obtained were organized, transformed ($\sqrt{(x+0,5)}$), subjected to a variance analysis and, Scott-Knott average test of separation at 5% probability, correlation and regression analysis. The general analysis of the experiment was considered the average effects of treatments on the dates, and these turned into blocks.

RESULTS

During this experiment a total of 4403 specimens were captured, divided into four orders: Diptera, Coleoptera,

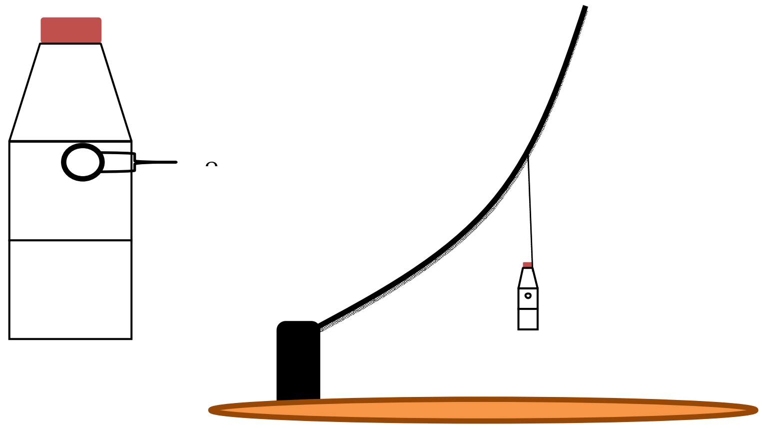

Figure 1. Representation of making and placing the bottle fly trap in fig tree.

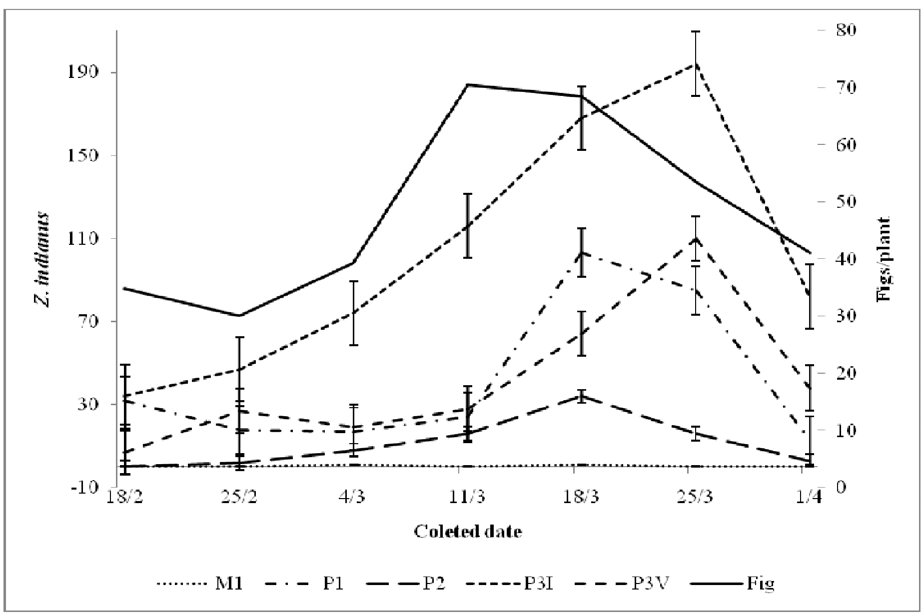

Figure 2. Efficiency of different traps models (M1, P1, P2, P3I and P3V) in the capture of *Zaprionus indianus* adults and fruit harvest average per plant (Fig) under different dates of evaluation in an fig orchard cv. "Roxo de Valinhos" in Santa Maria county, Rio Grande do Sul state, Brazil, 2010. Side bars represent the standard deviation of different trap types tested.

Lepidoptera and Hymenoptera. The Diptera were the most abundant, with 3850 adults, of these, 1387 were *Z. indianus* adults (Figure 2).

The traps models used P3I was superior, differing statistically from the others. P3V and P1 were shown to be statistically equal and higher than P2 and M1, these, with lower performance (Table 2).

The exchanges of syrup resulted in distinguish two capture periods, before and after its permanence. The first 291 and the second 1096 adults captured. The weekly capture values of *Z. indianus* adults during catch period are presented in table 2. The attack occurred in figs with anomalies, such as cracks or bird attack. In healthy figs no records were made.

Table 2. Efficiency of different traps types in capture of *Zaprionus indianus* in fig orchard cv. "Roxo de Valinhos" in Santa Maria county, Rio Grande do Sul state, Brazil, 2010.

Dates	Trap model					
	M1	P1	P2	P3I	P3V	CV%
			First period[1]			
18/2	0b*	8a	0b	8,5a	1.75b	41.67
25/2	0c	4.5b	0.5c	11.75a	6.75b	24.96
4/3	0.25d	4.25b	2c	18.5a	4.75b	17.07
$\bar{x}^3$	0.08c	5.58b	0.83c	12.92a	4.42b	23.72
SD[4] (±)	0.29	4.68	1.27	5.45	3.23	
			Second period[1]			
11/3	0c	6b	4b	29a	7b	19.13
18/3	0.25c	25.7a	8.5b	42a	16b	37.15
25/3	0c	21.25b	4c	48.5a	27.5b	22.44
1/4	0c	3.25c	0.75c	20.5a	9.75b	29.29
$\bar{x}$	0.06d	14.06b	4.31c	35.00a	15.00b	21.26
SD (±)	0.25	13.93	4.08	13.47	12.17	
			General analysis[2]			
$\bar{x}$	0.07d	10.42b	2.82c	25.53a	10.5b	26.78
SD (±)	0.26	11.62	3.6	15.38	10.72	

*Averages, in line, followed by different letters differ statistically by Scott-Knott test at 5% of probability. [1]Period corresponding to the interval between the placement of attractive solution in the trap and its removal (First period of three weeks and Second period of four weeks). [2]General analysis of the experiment considering the two periods. [3]Average. [4]Standard Deviation.

P3I was the most effective of traps types tested, with higher levels of capture of *Z. indianus* adults, in the first and second period, a weekly average of 12.92 (±5.45) and 35 (±13.47), statistically differing from other treatments at both periods (Table 2).

P3V presented a lower performance to P3I, statistically difference from the first and second period of capture, with an average weekly catch of 4.42 (±3.23) and 15.00 (±12.17) adults, respectively. P1 presented performance similar to P3V, had a weekly average for the two periods capture of 5.58 (±4.68) and 14.05 (±13.93) adults per trap, respectively.

P2 presented the lowest capture values for model Pet bottle. In M1, their values were not significant, showing for the two periods capture a sum of two adults of *Z. indianus*.

The attractiveness of the solution, on average, was negatively affected by the volume, with a great influence on the capture of *Z. indianus* adults. The production of the fig orchard correlated positively with of fig fly capture. The meteorological variables tested presented a low level of correlation with capture of *Z. indianus*. The population was influenced by local environmental and external factors to the orchard of fig.

DISCUSSION

The use of trap P3I can be recommended for monitoring and control the *Z. indianus*. Traps P3V and P1 may be used for monitoring work, but with adjustments in the density of traps is need in order to compensate, for their inefficiency when compared to P3I (Table 1). Catch levels obtained in P3I are lower than those obtained in previous works, but this fact is attributed to differences in attractive use, environment and climate (Raga and Souza Filho, 2003; Raga et al*.,* 2006).

The use of food bait was efficient on the Pet bottles models P3I, P3V and P1; of the P2 and M1 bottles were inefficient. One of the factors that contributed to capture efficiency was the variation in the volume of different traps models. Although same amount of attraction was used in all traps, special features such as exposure surface of the syrup to the atmosphere, which vary in different traps types, contributed to a greater loss of solution by evaporation, resulting in a decrease in volume and consequently in reduction in capture of insects. Of way decreasing sets out the traps with the largest loss in syrup: M1, P1, P2, P3, this same sequence, in a way increasing has the period of permanence of the trap in the orchard without the need for replacement or exchange of solution, ranging from seven days in M1, to 35 days for P3.

The bottles, P3I and P3V, showed greater stability with smaller changes in volume, which result in a longer period of the trap permanence in the orchard without the need for replacement or exchange reducing costs especially in labor. The variation of volume showed negative correlation when compared with the number of adults caught in all traps.

In M1, from placement of attractive solution in the trap until the first collection (one week), in consequence only 25% of the original volume, the following week did not exist, by the proposed of the experiment, that there is no replacement syrup in the collections. The use of this trap by the proposed method is not recommended for *Z. indianus*, but it is considered work where the trap in question was successful in catching the fly, using different substrates and volume (Raga and Souza Filho, 2003; Raga et al., 2006).

The trap M1 is not economically feasible to control pest the because of its high cost, US$ 10.00 dollars to drive to a low efficiency, suppressed by bottles from recycling at no cost of acquisition (Nakano et al., 1981). Numerous advantages can be related to the use of Pet bottles, such as reduced cost of fly control of the fig, the possibility of reusing the bottles for up to three years, ease of management and greater efficiency in the capture of the fly. In another analysis, it is considered that its efficiency is equivalent to P3I; an orchard of small size with 30 plants at a density of one trap per plant, there is a high cost for a relatively low efficiency, offset by trap models acquired free. Although this model has a high durability, alternative models with the only cost is labor and syrup production (Nakano et al., 1981).

During the experimental, P3I was more efficient than the other traps tested, showing a significant correlation when compared to the average of adults captured with fruit per plant collected (Figure 2). Its peak collection does not coincide with peak production of the orchard, the same goes for the other traps. The lower catch levels were obtained in the first weeks, which can be attributed to syrup fermentation, low population of adults in the orchard, the *Z. indianus* development cycle and orchard production, but this requires more studies to confirm these hypotheses.

There was an influence of trap color in the capture of adults. P3I had an average daily capture of 3.64 adult/trap; P3V had already 1.49 adults/trap/day, which demonstrates superiority of colorless traps. Although P1 had underperformed the P3I, this remained at levels comparable to P3V, indicating effect of color and specific conditions in the orchard. This case can also be attributed to comparative of P1 to P2 (Table 1 and 2) (Raga and Souza Filho, 2003; Link et al*.,* 1984; Scoz et al*.,* 2006). The trap model, indirectly influences the capture of *Z. indianus*, because it acts on variation syrup volume and this capture influences, different, the color of the trap directly influences the capture, this relationship is not valid for M1, is inefficiency can be attributed to other factors.

Equating the different effects obtained on the capture of adults of Z. indianus in fig orchard in the traps of greater efficiency, demonstrates that there is positive influence in figs production, and a negative effect of volume changes, These effects associated of the model and color trap, with food bait promotes a greater or lesser effect in the capture of *Z. indianus*.

In conclusion, the trap P3I, with attractive and volume used, was more efficient in capturing *Zaprionus indianus*. Traps P3V and P2 may be used with adjustments in its density and volume of attractive being used per trap. Trap M1 is inefficient. The colorless Pet bottles are more efficient in capturing adult of *Zaprionus indianus*.

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