Journal of Agricultural Science; Vol. 7, No. 3; 2015
ISSN 1916-9752 E-ISSN 1916-9760
Published by Canadian Center of Science and Education

Spatial Distribution of Adults of *Triozoida limbata* Enderlein, 1918 (Hemiptera: Triozidae) in Guava Orchards

Vera Alves de Sá[1] & Marcos Gino Fernandes[1]

[1] Programa de Pós-Graduação em Entomologia e Conservação da Biodiversidade, Universidade Federal da Grande Dourados (UFGD), Dourados, MS, Brazil

Correspondence: Vera Alves de Sá, Universidade Federal da Grande Dourados (UFGD), Faculdade de Ciências Biológicas e Ambientais, CEP: 79804-970, Dourados, MS, Brazil. E-mail: veraalves_bio@yahoo.com.br

Received: December 7, 2014 Accepted: January 6, 2015 Online Published: February 15, 2015

doi:10.5539/jas.v7n3p223 URL: http://dx.doi.org/10.5539/jas.v7n3p223

Abstract

The aim of this study was to carry out probabilistic analyses of the spatial distribution patterns of adults of *Triozoida limbata* Enderlein, 1918 (Hemiptera: Triozidae) in guava orchards. This study was conducted in four guava orchards in Ivinhema, Mato Grosso do Sul, Brazil. The samplings were conducted every fortnight from April 2012 to March 2014. A sampling area was set up for adult samples, and it consisted of 24 sampling units or plots with 15 plants in each (3 rows × 5 plants). A double-sided adhesive yellow trap was installed, 23 cm in length and 11 cm in width, around the central plant of each sampling unit, approximately 1.5 m from the ground. The dispersion rates (variance/mean ratio, Morisita index and Exponent k of the Negative Binomial Distribution) and the theoretical frequency distributions (Poisson and Negative Binomial) were calculated. Following the analyses, it can be concluded that the adults of *T. limbata* of the populations studied are randomly distributed in the four areas evaluated, with the sampling data fitting the Poisson distribution model.

Keywords: damage, horticulture, poisson distribution, *Psidium guajava* L., spatial arrangement

1. Introduction

Cultivation of guava is hindered by the presence of pest insects that cause different types of damage to the plants. One such insect is *Triozoida limbata* Enderlein, 1918 (Hemiptera: Triozidae), which is currently considered as one of the main guava crop pests in Brazil (Colombi & Galli, 2009). During the development of the plant, the young leaves are attacked by this insect (Sá, 2011), which sucks the sap from leaf edges and injects toxins in them (Munyaneza et al., 2010), causing the leaves to curl and wither, giving them the appearance of necrosis and limiting the production and quality of the fruits (Yana et al., 2010; Ndankeu et al., 2011).

The management of *T. limbata* is based on the use of chemical insecticides but with little regard to the population density and economic losses (Hassani et al., 2009). Furthermore, knowledge of the special distribution of the insect is not taken into account, a factor that is essential for establishing the best sampling criteria and determining the most appropriate moment to apply the pest control. To determine the pattern of spatial arrangement of a given species, it is necessary to collect data on the number of individuals. For this, the ecosystem in question needs to allow for sampling to be conducted (Fernandes et al., 2003). These samplings can be used to draw inferences about the form of distribution of the population sampled or about the characteristics of this distribution for which the indices of aggregation and frequency distribution are used (L. J. Young & J. H. Young, 1998).

Based on these facts, there is a need to understand the behavioral patterns of the spatial distribution of the population of *T. limbata*, to allow proposing a sampling program that seeks to minimize the use of chemical insecticides. Therefore, this study aims to perform probabilistic analyses of the patterns of the spatial distribution of adults of *T. limbata* in guava orchards.

2. Material and Methods

Samplings were performed from April 2012 to March of 2014 in four commercial guava orchards, Pedro Sato cultivar, in the municipality of Ivinhema - MS, Brazil, at the following locations: area 1, Gleba Piravevê, with a total of 550 plants: 22º16′32″S and 53º48′59″W at an altitude of 339 m; area 2, located in Gleba Vitória, with 300 plants: 22º20′51″S and 53º47′59″W at an altitude of 377 m; area 3, in Gleba Azul, with 2,800 plants:

22º16′22″S and 53º54′07″W at an altitude of 400 m; and area 4, in Gleba Ouro verde, with an orchard comprising 300 plants: 22º17′34″S and 53º56′15″W at a latitude of 377 m. Plants were seven and a half years old at the beginning of the sampling period and were planted with a spacing of 5 m × 7 m between plants; the irrigation used was by micro-aspersion. The soil in the region is classified as dystrophic Red Latosol, which comprises 70% sand and 18% clay.

Each area consisted of 24 sampling units or parcels containing 15 plants each (3 rows × 5 plants). A double-sided adhesive yellow trap was installed, 23 cm in length and 11 cm in width, around the central plant of each sampling unit, approximately 1.5m from the ground. The traps were changed every fortnight when they were taken to the laboratory to count the number of adult individuals. For data analysis, the square root transformation of x + 0.5 was used (Zucareli et al., 2009). The mean ($\hat{m}$) and variance (S^2) in the number of adults of *T. limbata* were obtained on each sampling date, taking the relationship between these values as an indicator of spatial distribution (Elliott, 1979). The dispersion indices, described below, were calculated for each of the samplings performed. Variance/mean ratio (I):values equal to the unit indicate random spatial distribution; values lower than the unit indicate uniform distribution, and values greater than the unit represent aggregate distribution (Rabinovich, 1980). Spatial randomness can be tested by the chi-square test with n-1 degrees of freedom, $\chi 2 = (n - 1)\ S^2/m$ (Elliott, 1979).

Morisita Index (I_δ): this index is relatively independent of the average and number of samples. Thus, when $I_\delta = 1$, the distribution is random; when $I_\delta > 1$, the distribution is of the contagious type, and when $I_\delta < 1$, this indicates a regular distribution (Morisita, 1962). Exponent k of the negative binomial distribution (k): this is an appropriate dispersion index when the size and number of sampling units are the same in each sample. Often, this is influenced by the size of the sample units. This parameter is an inverse measure of the degree of aggregation, and in this case, negative values indicate a regular or uniform distribution; positive values, close to zero, indicate aggregate arrangement; and values greater than eight indicate a random distribution (Southwood, 1978; Elliot, 1979). On this aspect, Poole (1974) uses another interpretation: when $0 < k < 8$, the index indicates aggregate distribution, and when $0 > k > 8$, this indicates random distribution.

The theoretical frequency distributions used to evaluate the spatial distribution of the species observed in the field were also used. These distributions are presented below: Poisson Distribution, also known as random distribution, is characterized by the variance that equals the mean ($S^2 = m$); Negative Binomial Distribution presents greater variance than the average, thereby indicating aggregate distribution, in addition to having two parameters as follows: the mean ($\hat{m}$) and parameter k ($k > 0$). The chi-square adhesion test was performed to check the adjustments f of the data collected in the field regarding the theoretical frequency distributions. Therefore, we used the chi-squared adhesion test, which compares the total frequencies observed in the sample area with the expected frequencies, according to (L. J. Young & J. H. Young, 1998). These frequencies are defined by the product of the probabilities of each class and the total number of sampling units used. For this test, it was decided to establish a minimum expected frequency that equals the unit. Statistical analysis was performed using the chi-square test at the levels of 1% and 5% probability.

3. Results and Discussion

In each area, 48 samplings were conducted. A total of 34,436 adults of *T. limbata* were captured in the traps. In the 2 years in which the populations of this insect were sampled, population peaks occurred between October and November in areas 1 and 4. In areas 2 and 3, the highest populations were recorded between April and May. The high number of individuals sampled in the orchards may have been because of the presence of young guava leaves during the sampling period, providing ideal conditions for the multiplication of *T. limbata* (Melo, 2009). The insect peak occurrences matched the intense presence of young leaves.

It was observed that the values of variance were below the mean in thirty-three samplings performed in area 1 (Table 1); in forty-two of the samplings in area 2 (Table 2); in twenty-seven samplings in area 3 (Table 3); and thirty-four samplings in area 4 (Table 4). The variance/mean ratio was significantly equal to the unit in forty-three of the samplings in area 1 (Table 1); forty-four samplings in area 2 (Table 2); thirty-nine samplings in area 3 (Table 3); and forty-four samplings in area 4 (Table 4).

The values of the Morisita Index found in this study and confirmed by the spatial randomness test demonstrate that the results were significantly equal to the unit in forty-three samplings in area 1 (Table 1); forty-four samplings in area 2 (Table 2); thirty-nine samplings in area 3 (Table 3); and forty-three samplings in area 4 (Table 4).

The values of the K parameter in area 1 were negative in thirty-three samplings, positive and lower than eight in 13 samplings, and higher than eight in two samplings (Table 1); in area 2, the values were negative in forty-two

samplings and positive and lower than 8 in six samplings (Table 2); for area 3 it was found that in twenty-seven samplings, the values were negative and in 16 they were positive and lower than 8 and in five samplings, the values were higher than eight (Table 3); in area 4 it was observed that the values were negative in thirty-four of the samplings, positive and lower than eight in 13 samplings, and in only one samplings, the value was higher than eight (Table 4). The three spatial distribution indices used in this research indicate that the spatial arrangement of adults of *T. limbata* is random in the four areas studied.

Table 1. Statistical analysis (means and variances) and dispersion index for adults of *Triozoida limbata* in guava orchard (area 1), in Ivinhema, Mato Grosso do Sul, Brazil, 2012/2014 (N = 24)

Index	Sampling date					
	10/04/12	25/04/12	10/05/12	25/05/12	09/06/12	24/06/12
$\widehat{m}$	10.667	10.125	12.125	19.583	9.458	8.375
S^2	6.928	5.418	21.158	15.297	4.955	4.418
I	0.649 ^{ns}	0.535 ^{ns}	1.745*	0.781 ^{ns}	0.524 ^{ns}	0.528 ^{ns}
I_δ	0.968 ^{ns}	0.956 ^{ns}	1.059 *	0.989 ^{ns}	0.952 ^{ns}	0.946 ^{ns}
K	-2.853 ^{un}	-2.151 ^{un}	1.342 ^{ag}	-4.569 ^{un}	-2.100 ^{un}	-2.117 ^{un}
X^2	14.938	12.309	40.134	17.966	12.048	12.134
	09/07/12	24/07/12	08/08/12	23/08/12	07/09/12	22/09/12
$\widehat{m}$	8.208	9.125	5.792	5.583	16.708	9.500
S^2	4.259	34.114	5.042	4.949	43.172	23.652
I	0.519 ^{ns}	3.739*	0.871 ^{ns}	0.886 ^{ns}	2.584*	2.490 *
I_δ	0.944 ^{ns}	1.289 *	0.978 ^{ns}	0.980 ^{ns}	1.091*	1.151*
K	-2.078 ^{un}	0.365 ^{ag}	-7.722 ^{un}	-8.806 ^{un}	0.631 ^{ag}	0.671 ^{ag}
X^2	11.934	85.986	20.022	20.388	59.429	57.263
	07/10/12	22/10/12	06/11/12	21/11/12	06/12/12	21/12/12
$\widehat{m}$	9.667	24.042	9.167	18.500	17.125	5.792
S^2	24.754	17.172	11.884	15.217	15.505	4.085
I	2.561 *	0.714 ^{ns}	1.296 ^{ns}	0.823 ^{ns}	0.905 ^{ns}	0.705 ^{ns}
I_δ	1.155*	0.989 ^{ns}	1.031 ^{ns}	0.991 ^{ns}	0.995 ^{ns}	0.951 ^{ns}
K	0.641 ^{ag}	-3.500 ^{un}	3.373 ^{ag}	-5.636 ^{un}	-10.574 ^{un}	-3.394 ^{un}
X^2	58.897	16.428	29.818	18.919	20.825	16.223
	05/01/13	20/01/13	04/02/13	19/02/13	06/03/13	21/03/13
$\widehat{m}$	14.417	13.458	7.708	6.917	6.583	6.042
S^2	14.254	14.955	4.216	8.949	8.341	6.998
I	0.989 ^{ns}	1.111 ^{ns}	0.547 ^{ns}	1.294 ^{ns}	1.267 ^{ns}	1.158 ^{ns}
I_δ	0.999 ^{ns}	1.008 ^{ns}	0.943 ^{ns}	1.041 ^{ns}	1.039 ^{ns}	1.025 ^{ns}
K	-88.422 ^{un}	8.994 ^{al}	-2.207 ^{un}	3.403 ^{ag}	3.746 ^{ag}	6.316 ^{ag}
X^2	22.740	25.557	12.578	29.759	29.139	26.641
	05/04/13	20/04/13	05/05/13	20/05/13	04/06/13	19/06/13
$\widehat{m}$	12.667	10.167	9.667	8.417	7.000	9.625
S^2	13.536	8.232	9.362	9.819	8.000	11.201
I	1.069 ^{ns}	0.810 ^{ns}	0.969 ^{ns}	1.167 ^{ns}	1.143 ^{ns}	1.164 ^{ns}
I_δ	1.005 ^{ns}	0.982 ^{ns}	0.997 ^{ns}	1.019 ^{ns}	1.020 ^{ns}	1.016 ^{ns}
K	14.567 ^{al}	-5.255 ^{un}	-31.762 ^{un}	6.003 ^{ag}	7.000 ^{ag}	6.107 ^{ag}
X^2	24.579	18.623	22.276	26.832	26.286	26.766

	04/07/13	19/07/13	03/08/13	18/08/13	02/09/13	17/09/13
$\widehat{m}$	7.833	6.208	6.875	6.167	11.542	8.042
S^2	4.667	6.172	4.462	4.232	16.172	5.520
I	0.596 ^{ns}	0.994 ^{ns}	0.649 ^{ns}	0.686 ^{ns}	1.401 ^{ns}	0.686 ^{ns}
I_δ	0.950 ^{ns}	0.999 ^{ns}	0.951 ^{ns}	0.951 ^{ns}	1.033 ^{ns}	0.962 ^{ns}
K	-2.474 ^{un}	-171.350 ^{un}	-2.849 ^{un}	-3.187 ^{un}	2.493 ^{ag}	-3.189 ^{un}
X^2	13.702	22.866	14.927	15.784	32.227	15.788
	02/10/13	17/10/13	01/11/13	16/11/13	01/12/13	16/12/13
$\widehat{m}$	6.958	7.500	6.625	7.292	5.500	6.708
S^2	3.955	4.435	3.636	4.042	3.565	3.781
I	0.568 ^{ns}	0.591 ^{ns}	0.549 ^{ns}	0.554 ^{ns}	0.648 ^{ns}	0.564 ^{ns}
I_δ	0.940 ^{ns}	0.947 ^{ns}	0.934 ^{ns}	0.941 ^{ns}	0.938 ^{ns}	0.937 ^{ns}
K	-2.317 ^{un}	-2.447 ^{un}	-2.216 ^{un}	-2.244 ^{un}	-2.843 ^{un}	-2.291 ^{un}
X^2	13.072	13.600	12.623	12.749	14.909	12.963
	31/12/13	15/01/14	30/01/14	14/02/14	01/03/14	16/03/14
$\widehat{m}$	5.458	6.542	9.250	8.458	7.083	7.083
S^2	3.389	3.911	8.370	4.520	4.428	3.993
I	0.621 ^{ns}	0.598 ^{ns}	0.905 ^{ns}	0.534 ^{ns}	0.625 ^{ns}	0.564 ^{ns}
I_δ	0.933 ^{ns}	0.941 ^{ns}	0.990 ^{ns}	0.947 ^{ns}	0.949 ^{ns}	0.941 ^{ns}
K	-2.638 ^{un}	-2.487 ^{un}	-10.506 ^{un}	-2.148 ^{un}	-2.667 ^{un}	-2.292 ^{un}
X^2	14.282	13.752	20.811	12.291	14.376	12.965

Note. * Significant at 5% probability; ^{ns} Non-significant at 5% probability; ^{AG} aggregate; ^{un} uniform; ^{al} Random; $\widehat{m}$ -mean; S^2 - Variance; I - Mean-variance ratio; I_δ - Morisita index; K - Exponent of the negative binominal; X^2 - calculated chi-square.

Table 2. Statistical analysis (means and variances) and dispersion index for adults of *Triozoida limbata* in guava orchard (area 2), in Ivinhema, Mato Grosso do Sul, Brazil, 2012/2014 (N = 24)

Index	Sampling date					
	10/04/12	25/04/12	10/05/12	25/05/12	09/06/12	24/06/12
$\widehat{m}$	20.500	8.625	7.875	6.542	5.167	7.083
S^2	13.391	13.723	4.201	4.085	3.275	3.906
I	0.653 ^{ns}	1.591 ^{ns}	0.533 ^{ns}	0.624 ^{ns}	0.634 ^{ns}	0.551 ^{ns}
I_δ	0.984 ^{ns}	1.066 *	0.943 ^{ns}	0.945 ^{ns}	0.932 ^{ns}	0.939 ^{ns}
K	-2.884 ^{un}	1.692 ^{ag}	-2.143 ^{un}	-2.663 ^{un}	-2.732 ^{un}	-2.229 ^{un}
X^2	15.024	36.594	12.270	14.363	14.581	12.682
	09/07/12	24/07/12	08/08/12	23/08/12	07/09/12	22/09/12
$\widehat{m}$	6.833	5.292	3.792	4.708	4.542	4.792
S^2	4.058	3.607	2.694	3.607	3.129	3.042
I	0.594 ^{ns}	0.682 ^{ns}	0.710 ^{ns}	0.766 ^{ns}	0.689 ^{ns}	0.635 ^{ns}
I_δ	0.943 ^{ns}	0.942 ^{ns}	0.926 ^{ns}	0.952 ^{ns}	0.934 ^{ns}	0.926 ^{ns}
K	-2.462 ^{un}	-3.141 ^{un}	-3.454 ^{un}	-4.275 ^{un}	-3.214 ^{un}	-2.738 ^{un}
X^2	13.659	15.677	16.341	17.619	15.844	14.600
	07/10/12	22/10/12	06/11/12	21/11/12	06/12/12	21/12/12
$\widehat{m}$	3.500	7.917	8.917	10.958	8.833	11.083
S^2	2.522	9.993	7.384	32.911	30.319	32.601

I	0.720 ns	1.262 ns	0.828 ns	3.003*	3.432 *	2.941 *
I_δ	0.923 ns	1.032 ns	0.981 ns	1.176*	1.265 *	1.169 *
K	-3.578 un	3.813 ag	-5.818 un	0.499 ag	0.411 ag	0.515 ag
X^2	16.571	29.032	19.047	69.076	78.943	67.654
	05/01/13	20/01/13	04/02/13	19/02/13	06/03/13	21/03/13
$\widehat{m}$	19.125	14.667	19.000	4.083	4.292	3.708
S^2	10.723	3.536	14.000	2.862	2.998	5.259
I	0.561 ns	0.241 ns	0.737 ns	0.701 ns	0.699 ns	1.418 ns
I_δ	0.978 ns	0.950 ns	0.987 ns	0.929 ns	0.932 ns	1.109 ns
K	-2.276 un	-1.318 un	-3.800 un	-3.344 un	-3.318 un	2.391 ag
X^2	12.895	5.545	16.947	16.122	16.068	32.618
	05/04/13	20/04/13	05/05/13	20/05/13	04/06/13	19/06/13
$\widehat{m}$	13.833	12.333	10.417	9.958	9.708	12.083
S^2	9.014	11.188	10.167	6.303	7.172	9.471
I	0.652 ns	0.907 ns	0.976 ns	0.633 ns	0.739 ns	0.784 ns
I_δ	0.976 ns	0.993 ns	0.998 ns	0.965 ns	0.974 ns	0.983 ns
K	-2.871 un	-10.772 un	-41.667 un	-2.724 un	-3.828 un	-4.626 un
X^2	14.988	20.865	22.448	14.556	16.991	18.028
	04/07/13	19/07/13	03/08/13	18/08/13	02/09/13	17/09/13
$\widehat{m}$	10.375	10.542	9.542	8.125	7.125	6.917
S^2	6.592	5.563	5.303	4.897	5.071	4.428
I	0.635 ns	0.528 ns	0.556 ns	0.603 ns	0.712 ns	0.640 ns
I_δ	0.966 ns	0.957 ns	0.955 ns	0.953 ns	0.961 ns	0.950 ns
K	-2.743 un	-2.118 un	-2.251 un	-2.517 un	-3.468 un	-2.779 un
X^2	14.614	12.138	12.782	13.862	16.368	14.723
	02/10/13	17/10/13	01/11/13	16/11/13	01/12/13	16/12/13
$\widehat{m}$	6.375	6.667	6.250	5.250	5.542	5.542
S^2	5.114	4.754	1.587	1.413	1.998	2.259
I	0.802 ns	0.713 ns	0.254 ns	0.269 ns	0.361 ns	0.408 ns
I_δ	0.970 ns	0.958 ns	0.885 ns	0.866 ns	0.889 ns	0.897 ns
K	-5.056 un	-3.485 un	-1.340 un	-1.368 un	-1.564 un	-1.688 un
X^2	18.451	16.400	5.840	6.190	8.293	9.376
	31/12/13	15/01/14	30/01/14	14/02/14	01/03/14	16/03/14
$\widehat{m}$	5.625	3.542	3.750	3.875	3.750	3.917
S^2	1.636	1.389	1.413	1.679	1.761	1.906
I	0.291 ns	0.392 ns	0.377 ns	0.433 ns	0.470 ns	0.487 ns
I_δ	0.878 ns	0.834 ns	0.839 ns	0.858 ns	0.863 ns	0.873 ns
K	-1.410 un	-1.646 un	-1.605 un	-1.765 un	-1.885 un	-1.948 un
X^2	6.689	9.024	8.667	9.968	10.800	11.191

Note. * Significant at 5% probability; ns Non-significant at 5% probability; AG aggregate; un uniform; $\widehat{m}$-mean; S^2 - Variance; *I* - Mean-variance ratio; I_δ - Morisita index; *K* - Exponent of the negative binominal; X^2 - calculated chi-square.

Table 3. Statistical analysis (means and variances) and dispersion index for adults of *Triozoida limbata* in guava orchard (area 3), in Ivinhema, Mato Grosso do Sul, Brazil, 2012/2014 (N = 24)

Index	Sampling date					
	10/04/12	25/04/12	10/05/12	25/05/12	09/06/12	24/06/12
$\widehat{m}$	8.833	8.083	15.125	8.333	3.750	3.375
S^2	7.797	4.775	59.245	16.928	3.761	3.201
I	0.883 ^{ns}	0.591 ^{ns}	3.917*	2.031 *	1.003 ^{ns}	0.948 ^{ns}
I_δ	0.987 ^{ns}	0.951 ^{ns}	1.185*	1.119 *	1.001 ^{ns}	0.985 ^{ns}
K	-8.524 ^{un}	-2.444 ^{un}	0.343 ^{ag}	0.970 ^{ag}	345.000 ^{al}	-19.406 ^{un}
X^2	20.302	13.588	90.091	46.720	23.067	21.815
	09/07/12	24/07/12	08/08/12	23/08/12	07/09/12	22/09/12
$\widehat{m}$	4.625	5.167	3.417	3.458	3.042	4.375
S^2	2.940	3.188	3.906	3.911	3.520	1.723
I	0.636 ^{ns}	0.617 ^{ns}	1.143 ^{ns}	1.131 ^{ns}	1.157 ^{ns}	0.394 ^{ns}
I_δ	0.924 ^{ns}	0.928 ^{ns}	1.041 ^{ns}	1.037 ^{ns}	1.050 ^{ns}	0.866 ^{ns}
K	-2.745 ^{un}	-2.612 ^{un}	6.9852 ^{ag}	7.636 ^{ag}	6.360 ^{ag}	-1.650 ^{un}
X^2	14.622	14.194	26.293	26.012	26.616	9.057
	07/10/12	22/10/12	06/11/12	21/11/12	06/12/12	21/12/12
$\widehat{m}$	4.125	5.417	5.083	3.375	12.333	10.958
S^2	2.027	9.210	8.428	3.723	41.710	29.085
I	0.491 ^{ns}	1.700 *	1.658 *	1.103 ^{ns}	3.382 *	2.654 *
I_δ	0.881 ^{ns}	1.125 *	1.125 *	1.030 ^{ns}	1.186 *	1.145 *
K	-1.966 ^{un}	1.428 ^{ag}	1.520 ^{ag}	9.703 ^{al}	0.420 ^{ag}	0.605 ^{ag}
X^2	11.303	39.108	38.131	25.370	77.784	61.046
	05/01/13	20/01/13	04/02/13	19/02/13	06/03/13	21/03/13
$\widehat{m}$	12.792	6.208	14.875	10.208	6.583	6.833
S^2	31.129	17.216	39.505	13.389	9.645	8.406
I	2.434 *	2.773 *	2.656 *	1.312 ^{ns}	1.465 ^{ns}	1.230 ^{ns}
I_δ	1.108 *	1.276 *	1.107 *	1.029 ^{ns}	1.068 ^{ns}	1.032 ^{ns}
K	0.698 ^{ag}	0.564 ^{ag}	0.604 ^{ag}	3.209 ^{ag}	2.150 ^{ag}	4.346 ^{ag}
X^2	55.971	63.779	61.084	30.167	33.696	28.293
	05/04/13	20/04/13	05/05/13	20/05/13	04/06/13	19/06/13
$\widehat{m}$	4.250	4.167	3.625	3.208	4.625	4.125
S^2	2.891	2.406	2.679	1.650	1.375	1.245
I	0.680 ^{ns}	0.577 ^{ns}	0.739 ^{ns}	0.514 ^{ns}	0.297 ^{ns}	0.302 ^{ns}
I_δ	0.927 ^{ns}	0.902 ^{ns}	0.930 ^{ns}	0.853 ^{ns}	0.853 ^{ns}	0.836 ^{ns}
K	-3.128 ^{un}	-2.366 ^{un}	-3.833 ^{un}	-2.059 ^{un}	-1.423 ^{un}	-1.432 ^{un}
X^2	15.647	13.280	17.000	11.831	6.838	6.939
	04/07/13	19/07/13	03/08/13	18/08/13	02/09/13	17/09/13
$\widehat{m}$	3.458	4.333	3.917	3.708	4.042	4.500
S^2	1.650	3.971	2.688	2.303	4.216	4.870
I	0.477 ^{ns}	0.916 ^{ns}	0.686 ^{ns}	0.621 ^{ns}	1.043 ^{ns}	1.082 ^{ns}

I_δ	0.853 ns	0.981 ns	0.922 ns	0.901 ns	1.010 ns	1.018 ns
K	-1.913 un	-11.960 un	-3.189 un	-2.638 un	23.240 al	12.176 al
X^2	10.976	21.077	15.787	14.281	23.990	24.889
	02/10/13	17/10/13	01/11/13	16/11/13	01/12/13	16/12/13
$\widehat{m}$	4.458	4.292	4.167	3.833	3.958	3.792
S^2	3.042	2.737	2.841	3.797	2.737	2.868
I	0.682 ns	0.638 ns	0.682 ns	0.991 ns	0.692 ns	0.756 ns
I_δ	0.931 ns	0.918 ns	0.926 ns	0.998 ns	0.925 ns	0.938 ns
K	-3.147 un	-2.761 un	-3.142 un	-105.800 un	-3.242 un	-4.104 un
X^2	15.692	14.670	15.680	22.783	15.905	17.396
	31/12/13	15/01/14	30/01/14	14/02/14	01/03/14	16/03/14
$\widehat{m}$	3.625	4.375	2.667	3.125	3.083	3.625
S^2	2.853	3.375	2.754	3.853	2.428	3.201
I	0.787 ns	0.771 ns	1.033 ns	1.233 ns	0.787 ns	0.883 ns
I_δ	0.943 ns	0.949 ns	1.012 ns	1.072 ns	0.933 ns	0.969 ns
K	-4.697 un	-4.375 un	30.667 al	4.291 ag	-4.702 un	-8.551 un
X^2	18.103	17.743	23.750	28.360	18.108	20.310

Note. * Significant at 5% probability; ns Non-significant at 5% probability; AG aggregate; un uniform; al Random; $\widehat{m}$-mean; S^2 - Variance; *I* - Mean-variance ratio; I_δ - Morisita index; *K* - Exponent of the negative binominal; X^2 - calculated chi-square.

Table 4. Statistical analysis (means and variances) and dispersion index for adults of *Triozoida limbata* in guava orchard (area 4), in Ivinhema, Mato Grosso do Sul, Brazil, 2012/2014 (N = 24)

Index	Sampling date					
	10/04/12	25/04/12	10/05/12	25/05/12	09/06/12	24/06/12
$\widehat{m}$	9.458	8.917	11.833	11.292	9.500	9.333
S^2	5.216	6.341	7.275	6.911	5.130	4.928
I	0.551 ns	0.711 ns	0.615 ns	0.612 ns	0.540 ns	0.528 ns
I_δ	0.954 ns	0.969 ns	0.969 ns	0.967 ns	0.953 ns	0.951 ns
K	-2.229 un	-3.461 un	-2.596 un	-2.578 un	-2.174 un	-2.118 un
X^2	12.683	16.355	14.141	14.077	12.421	12.143
	09/07/12	24/07/12	08/08/12	23/08/12	07/09/12	22/09/12
$\widehat{m}$	5.625	6.083	6.000	6.042	8.917	8.542
S^2	3.027	3.384	3.652	3.259	12.428	10.433
I	0.538 ns	0.556 ns	0.609 ns	0.539 ns	1.394 ns	1.221 ns
I_δ	0.921 ns	0.930 ns	0.937 ns	0.926 ns	1.043 ns	1.025 ns
K	-2.165 un	-2.254 un	-2.556 un	-2.171 un	2.540 ag	4.516 ag
X^2	12.378	12.795	14.000	12.407	32.056	28.093
	07/10/12	22/10/12	06/11/12	21/11/12	06/12/12	21/12/12
$\widehat{m}$	6.667	6.417	17.208	16.417	10.667	10.167
S^2	12.928	12.514	23.824	23.645	8.928	9.797
I	1.939 *	1.950 *	1.384 ns	1.440 ns	0.837 ns	0.964 ns

I_δ	1.136 *	1.143 *	1.021 ns	1.026 ns	0.985 ns	0.997 ns
K	1.065 ag	1.052 ag	2.601 ag	2.271 ag	-6.133 un	-27.510 un
X^2	44.600	44.857	31.843	33.127	19.250	22.164
	05/01/13	20/01/13	04/02/13	19/02/13	06/03/13	21/03/13
$\widehat{m}$	5.583	5.417	5.292	4.875	4.792	4.792
S^2	10.080	9.471	7.607	7.071	6.955	5.824
I	1.805 *	1.748 *	1.438 ns	1.450 ns	1.451 ns	1.216 ns
I_δ	1.139 *	1.133 *	1.080 ns	1.089 ns	1.091 ns	1.043 ns
K	1.242 ag	1.336 ag	2.286 ag	2.220 ag	2.215 ag	4.640 ag
X^2	41.522	40.215	33.063	33.359	33.383	27.957
	05/04/13	20/04/13	05/05/13	20/05/13	04/06/13	19/06/13
$\widehat{m}$	6.000	5.958	5.917	5.250	6.208	6.000
S^2	9.391	6.650	4.514	3.761	3.563	3.739
I	1.565 ns	1.116 ns	0.763 ns	0.716 ns	0.574 ns	0.623 ns
I_δ	1.091 *	1.019 ns	0.961 ns	0.948 ns	0.934 ns	0.939 ns
K	1.769 ag	8.610 al	-4.220 un	-3.526 un	-2.347 un	-2.654 un
X^2	36.000	25.671	17.549	16.476	13.201	14.333
	04/07/13	19/07/13	03/08/13	18/08/13	02/09/13	17/09/13
$\widehat{m}$	5.833	4.750	6.000	5.375	5.542	5.375
S^2	3.449	3.065	4.087	4.245	3.563	1.375
I	0.591 ns	0.645 ns	0.681 ns	0.790 ns	0.643 ns	0.256 ns
I_δ	0.932 ns	0.928 ns	0.949 ns	0.962 ns	0.938 ns	0.866 ns
K	-2.447 un	-2.819 un	-3.136 un	-4.755 un	-2.801 un	-1.344 un
X^2	13.600	14.842	15.667	18.163	14.789	5.884
	02/10/13	17/10/13	01/11/13	16/11/13	01/12/13	16/12/13
$\widehat{m}$	6.042	6.125	5.542	5.750	5.417	4.833
S^2	3.781	2.375	1.998	3.413	1.906	1.884
I	0.626 ns	0.388 ns	0.361 ns	0.594 ns	0.352 ns	0.390 ns
I_δ	0.940 ns	0.904 ns	0.889 ns	0.932 ns	0.884 ns	0.878 ns
K	-2.672 un	-1.633 un	-1.564 un	-2.460 un	-1.543 un	-1.639 un
X^2	14.393	8.918	8.293	13.652	8.092	8.966
	31/12/13	15/01/14	30/01/14	14/02/14	01/03/14	16/03/14
$\widehat{m}$	5.125	4.750	6.292	6.667	5.833	5.750
S^2	2.114	1.239	3.607	2.493	1.623	2.196
I	0.413 ns	0.261 ns	0.573 ns	0.374 ns	0.278 ns	0.382 ns
I_δ	0.889 ns	0.850 ns	0.935 ns	0.909 ns	0.881 ns	0.896 ns
K	-1.702 un	-1.353 un	-2.343 un	-1.597 un	-1.386 un	-1.618 un
X^2	9.488	6.000	13.185	8.600	6.400	8.783

Note. * Significant at 5% probability; ns Non-significant at 5% probability; AG aggregate; un uniform; al Random; $\widehat{m}$-mean; S^2 - Variance; *I* - Mean-variance ratio; I_δ - Morisita index; *K* - Exponent of the negative binominal; X^2 - calculated chi-square.

In relation to the tests on the frequency fits of numerical classes of adults of *T. limbata*, it was observed that in area 1, the values of the chi-squared test were not significant for Poisson's Distribution in forty-three samplings, indicating that the distribution is random. For the Negative Binomial Distribution, only one sampling was not significant, indicating that the distribution is not aggregate. In area 2, the values of the chi-squared test were not significant for the Poisson distribution in forty-four samplings, suggesting a random distribution. For the Negative Binomial Distribution of the thirty-seven samplings tested, all were significant, indicating that the distribution is not contagious (Table 5).

Table 5. Chi-square adhesion test of the expected frequencies of Poisson and Negative Binomial (Bn) distributions, spatial arrangement for adults of *Triozoida limbata*, in Ivinhema, Mato Grosso do Sul, Brazil, (areas 1 and 2), 2012/2014

Sampling date	Area 1				Area 2			
	Poisson		Bn		Poisson		Bn	
	X^2	DF (nc-2)	X^2	DF (nc-3)	X^2	DF (nc-2)	X^2	DF (nc-3)
10/04/12	11.472 ns	9	2755.112 *	9	17.394 ns	10	8050.735 *	21
25/04/12	10.219 ns	9	2831.089 *	8	18.826 ns	11	4674.427 *	18
10/05/12	22.190 ns	13	6742.407 *	21	8.747 ns	8	1513.727 *	13
25/05/12	11.443 ns	13	8670.821 *	25	11.033 ns	6	1263.396 *	6
09/06/12	14.823 ns	8	2450.268 *	7	6.160 ns	7	1195.837 *	4
24/06/12	12.772 ns	7	1543.713 *	7	4.389 ns	6	619.090 *	13
09/07/12	13.581 ns	7	1130.893 *	6	4.916 ns	6	1221.341 *	6
24/07/12	84.997 *	15	6719.734 *	22	5.004 ns	5	806.056 *	4
08/08/12	6.846 ns	7	1737.431*	10	3.719 ns	4	318.984 *	6
23/08/12	6.743 ns	7	1212.895 *	8	8.090 ns	7	1014.485 *	6
07/09/12	66.438 *	19	9855.360 *	27	3.996 ns	6	1074.079 *	5
22/09/12	77.192 *	12	4653.970 *	18	8.925 ns	7	1302.389 *	5
07/10/12	67.926 *	12	3348.915 *	15	3.582 ns	4	289.581 *	3
22/10/12	13.662 ns	13	11449.129 *	27	9.074 ns	10	4236.288 *	17
06/11/12	35.187 *	11	4692.617 ns	28	5.162 ns	9	3064.622 *	14
21/11/12	15.655 ns	13	8657.539 *	25	179.220 *	13	11276.412 *	20
06/12/12	21.555 ns	14	7403.414 *	22	117.820 *	14	6166.715 *	21
21/12/12	12.118 ns	6	816.622 *	4	244.261 *	14	7903.094 *	24
05/01/13	8.064 ns	11	4726.785 *	18	12.520 ns	12	8792.618 *	21
20/01/13	11.902 ns	11	4249.202 *	27	11.533 ns	8	-	-
04/02/13	8.459 ns	8	1699.025 *	7	20.461 ns	12	8059.574 *	22
19/02/13	15.824 ns	9	1976.112 *	11	6.601 ns	6	1268.077 *	8
06/03/13	15.272 ns	9	1978.332 *	11	9.256 ns	5	738.327 *	5
21/03/13	10.171 ns	8	1988.123 *	11	10.522 ns	6	742.751 *	6
05/04/13	16.229 ns	9	2018.525 *	15	87.255 *	9	3508.782 *	12
20/04/13	13.162 ns	9	2700.215 *	11	40.578 ns	10	3432.244 *	15
05/05/13	15.430 ns	9	2667.821 *	13	9.490 ns	10	3420.996 *	15
20/05/13	15.964 ns	9	2643.507 *	13	13.322 ns	9	2765.014 *	10
04/06/13	6.300 ns	8	1988.411 *	11	9.149 ns	9	2722.400 *	11

19/06/13	17.320 ns	10	2643.085 *	13	11.563 ns	10	3462.618 *	13
04/07/13	6.640 ns	8	1818.366 *	7	12.388 ns	9	2762.921 *	10
19/07/13	7.581 ns	9	1713.317 *	10	6.305 ns	9	2834.786 *	9
03/08/13	6.783 ns	7	1805.505 *	6	8.463 ns	9	2815.911 *	10
18/08/13	11.529 ns	7	1261.607 *	6	15.485 ns	8	2442.592 *	9
02/09/13	21.217 ns	13	3788.678 *	16	9.991 ns	8	1776.856 *	7
17/09/13	9.277 ns	8	1781.754 *	9	6.759 ns	7	1534.331 *	7
02/10/13	7.812 ns	6	1025.387 *	6	14.440 ns	8	1478.344 *	8
17/10/13	10.271 ns	6	1243.797 *	6	13.869 ns	9	1778.748 *	8
01/11/13	10.639 ns	7	3167.180 *	7	10.995 ns	6	-	-
16/11/13	12.076 ns	6	850.145 *	4	10.400 ns	5	-	-
01/12/13	7.236 ns	6	1097.678 *	4	11.379 ns	6	-	-
16/12/13	9.183 ns	6	817.989 *	3	8.811 ns	5	-	-
31/12/13	4.354 ns	6	1234.341 *	5	10.172 ns	5	-	-
15/01/14	7.610 ns	6	1221.222 *	5	9.108 ns	4	-	-
30/01/14	9.791 ns	9	2337.098*	9	5.401 ns	4	-	-
14/02/14	8.513 ns	6	1906.865 *	4	6.131 ns	5	-	-
01/03/14	11.013 ns	6	1268.295 *	6	3.942 ns	4	-	-
16/03/14	5.528 ns	6	984.612 *	4	3.692 ns	5	-	-

Note. * Significant at 5% probability; ns Non-significant; I insufficient of classes; X^2- chi-square value calculated; DF - degree of freedom; nc-number of classes observed at field.

In relation to the fits of the frequencies in area 3, forty-two samplings were not significant for the Poisson distribution, while in area 4 this result was observed in forty-three samplings. For the Negative Binomial Distribution, all forty-one samplings tested in area 3 and thirty-seven in area 4 had significant chi-squared values, indicating that there was no fit to this type of distribution (Table 6).

Table 6. Chi-square adhesion test of the expected frequencies of Poisson and Negative Binomial (Bn) distributions, spatial arrangement for adults of *Triozoida limbata,* in Ivinhema, Mato Grosso do Sul, Brazil, (areas 3 and 4), 2012/2014

Sampling date	Area 3				Area 4			
	Poisson		Bn		Poisson		Bn	
	X^2	DF (nc-2)	X^2	DF (nc-2)	X^2	DF (nc-2)	X^2	DF (nc-2)
10/04/12	17.307 ns	10	2685.075 *	13	15.425 ns	8	2463.927 *	9
25/04/12	13.900 ns	9	2451.802 *	10	15.979 ns	9	2389.860 *	9
10/05/12	472.643 *	20	9847.830 *	27	10.736 ns	10	3949.727 *	12
25/05/12	16.643 ns	12	3355.921 *	15	13.455 ns	10	3953.331 *	12
09/06/12	12.477 ns	7	1202.290 *	8	12.135 ns	7	2176.323 *	8
24/06/12	11.725 ns	6	992.303 *	7	13.814 ns	9	2455.624 *	9
09/07/12	7.037 ns	7	1377.494 *	6	11.458 ns	6	27336.861 *	5
24/07/12	10.559 ns	6	1390.555 *	5	2.950 ns	6	3876.036 *	5
08/08/12	11.981 ns	6	1185.508 *	8	4.584 ns	6	1225.478 *	5
23/08/12	12.018 ns	6	962.765 *	7	3.984 ns	7	-	-

07/09/12	8.675 ns	7	962.194 *	7	13.708 ns	11	3378.244 *	15
22/09/12	6.527 ns	5	-	-	13.923 ns	9	2638.371 *	13
07/10/12	7.351 ns	5	-	-	12.703 ns	9	3769.750 *	16
22/10/12	9.187 ns	8	2276.736 *	12	15.220 ns	10	3769.635 *	16
06/11/12	5.053 ns	7	2616.418 *	13	21.007 ns	13	8568.116 *	25
21/11/12	8.740 ns	6	1189.956 *	8	21.918 ns	14	7937.754 *	24
06/12/12	133.879 *	16	9176.173 *	26	15.248 ns	11	4301.907 *	16
21/12/12	174.313 *	16	5134.424 *	19	16.098 ns	10	3836.604 *	16
05/01/13	175.410 *	14	5136.478 *	19	77.247 *	8	2274.013 *	12
20/01/13	157.958 *	11	2597.863 *	13	114.071 *	8	1958.603 *	11
04/02/13	78.040 *	17	7905.088 *	24	34.333 *	7	1677.162 *	10
19/02/13	17.376 ns	10	2630.674 *	13	37.599 *	9	1676.813 *	10
06/03/13	15.576 ns	9	2987.599 *	14	41.679 *	9	1676.960 *	10
21/03/13	14.244 ns	9	2639.091 *	13	11.359 ns	7	1421.437 *	9
05/04/13	2.313 ns	10	844.006 *	3	13.331 ns	7	1400.802 *	9
20/04/13	6.873 ns	5	73178.136 *	4	2.580 ns	8	1427.802 *	9
05/05/13	6.760 ns	5	706.134 *	5	5.220 ns	7	1240.413 *	7
20/05/13	5.021 ns	4	-	-	2.146 ns	6	1034.056 *	7
04/06/13	9.406 ns	5	-	-	4.264 ns	5	1867.683 *	5
19/06/13	7.308 ns	4	-	-	3.212 ns	9	1139.528 *	5
04/07/13	7.391 ns	4	-	-	4.350 ns	6	1562.712 *	5
19/07/13	1.158 ns	6	987.071 *	7	3.179 ns	7	1212.791 *	5
03/08/13	6.102 ns	6	692.152 *	6	11.612 ns	6	1045.213 *	5
18/08/13	9.209 ns	4	-	-	4.561 ns	7	1235.643 *	8
02/09/13	5.392 ns	7	969.879 *	6	5.876 ns	6	1108.534 *	5
17/09/13	8.829 ns	6	763.074 *	6	11.034 ns	5	-	-
02/10/13	6.838 ns	5	779.691 *	5	5.586 ns	6	1125.988 *	5
17/10/13	7.341 ns	5	3451.249 *	5	7.454 ns	6	-	-
01/11/13	10.441 ns	5	852.505 *	5	7.796 ns	6	-	-
16/11/13	12.498 ns	6	777.631 *	5	5.239 ns	6	1557.509 *	5
01/12/13	11.419 ns	6	1258.220 *	7	11.821 ns	6	-	-
16/12/13	8.924 ns	6	1038.074 *	7	6.555 ns	5	-	-
31/12/13	11.683 ns	6	811.727 *	5	7.845 ns	6	-	-
15/01/14	10.056 ns	5	639.456 *	5	10.802 ns	5	-	-
30/01/14	9.492 ns	5	984.644 *	7	5.068 ns	5	1816.831 *	5
14/02/14	8.784 ns	6	955.651 *	7	9.250 ns	6	-	-
01/03/14	7.821 ns	6	674.782 *	5	12.431 ns	6	-	-
16/03/14	9.726 ns	5	649.853 *	5	5.310 ns	6	-	-

Note. * Significant at 5% probability; ns Non-significant; I insufficient of classes; X^2- chi-square value calculated; DF - degree of freedom; nc-number of classes observed at field.

The data obtained in 89.58% of the samplings studied from the orchards fits the Poisson's distribution, indicating a random model of distribution of the adults of *T. limbata*. In studies with adults of *Bactericera cockerelli*

(Hemiptera: Triozidae), it was found that in the green tomato crop, the spatial distribution was also random (Crespo-Herrera et al., 2012). The random distribution found in this work occurs when the environmental conditions are similar in any point of the area, and the presence of one organism does not interfere with the presence of another individual nearby, indicating the absence or reduced interaction among individuals, and between these and the environment (Begon et al., 1996). In this type of arrangement, the energy expenditure on reproduction is lower because the males can find females without having to extensively search the area (Shea et al., 1993). In addition, the population gains greater genetic variability because the insects that come into the crop can find reproductive partners more easily (Diekötter et al., 2008), and it would be difficult for the entire population to be affected (Courtney, 1986).

Considering that the damage is also distributed in a random manner, the applications of insecticides at the wrong time or in an uneven way could undermine the efficiency in the integrated pest control because various individuals in the population may not be reached. Thus, the surviving insects could remain in the crop with sufficient energy to reproduce and begin a new cycle of attack (Alves, 2012). Knowledge of the spatial arrangement of the adults of *T. limbata* is of vital importance for determining the best sampling criteria and deciding on the best moment to apply the pest control. Thus, the results of this research will contribute to the development of future sequential sampling plans for *T. limbata*, which is aimed at defining the exact number of samplings to be used.

4. Conclusion

The adults of *Triozoida limbata* of the populations are arranged randomly in the four areas evaluated, with the sampling data fitting the Poisson distribution model.

References

Alves, T. C. (2012). *Distribuição espacial do percevejo-do-colmo (Tibraca limbativentris Stål) em arroz irrigado*. (Dissertação de Mestrado). Escola de Agronomia e Engenharia de Alimentos, Universidade Federal de Goiás, Goiânia, Brasil.

Begon, M., Harper, J. L., & Towsend, C. R. (1996). *Ecology: individuals, populations and communities* (3rd ed.). Oxford, Blackwell Science.

Colombi, C. A., & Galli, J. C. (2009). Dinâmica populacional e evolução de dano de *Triozoida limbata* (Hemiptera: Psillydae) em goiabeira, em Jaboticabal, SP. *Ciência e Agrotecnologia, 33,* 412-416. http://dx.doi.org/10.1590/S1413-70542009000200008

Courtney, S. P. (1986). Why insects move between host patches: some comments on risck-spreading. *Oikos, 47*(1), 112-114.

Crespo-Herrera, L. A., Vera-Graziano, J., Bravo-Mojica, H., López-Collado, J., Reyna-Robles, R., Peña-Lomelí, A., ... Garza-García, R. (2012). Distribución espacial de *Bactericera cockerelli* (Sulc) (Hemiptera: Triozidae) en tomate de cáscara (*Physalis ixocarpa* (Brot.)). *Agrociencia, 46*(3), 289-298.

Diekötter, T., Billeter, R., & Crist, T. O. (2008). Effects of landscape connectivity on the spatial distribution of insect diversity in agricultural mosaic landscapes. *Basic and Applied Ecology, 9*(3), 298-307. http://dx.doi.org/10.1016/j.baae.2007.03.003

Elliott, J. M. (1979). *Some methods for the statistical analysis of sample benthic invertebrates* (1st ed.). Ambleside: Freshwater Biological Association.

Fernandes, M. G., Busoli, A. C., & Barbosa, J. C. (2003). Distribuição espacial de *Alabama argillacea* (Hübner) (Lepidoptera: Noctuidae) em algodoeiro. *Neotropical Entomology, 32*(1), 107-115. http://dx.doi.org/10.1590/S1519-566X2003000100016

Hassani, M. R., Nouri-Ganbalani, G., Izadi, H., Shojai, M., & Basirat, M. (2009). Economic injury level of the psyllid, *Agonoscena pistaciae*, on pistachio, *Pistacia vera* cv. Ohadi. *Journal of Insect Science, 9*, 1-4. http://dx.doi.org/10.1673/031.009.4001

Melo, G. (2009). *Dinâmica populacional e inimigos naturais de Triozoida limbata (Hemiptera: Triozidae) e diversidade de famílias de himenópteros parasitoides em pomar convencional e orgânico de goiaba na região de Campinas, SP.* (Dissertação de Mestrado). Instituto Biológico. Campinas, Brasil.

Morisita, M. (1962). Id-index, a measure of dispersion of individuals. *Journal: Researches on Population Ecology, 4*(1), 1-7.

Munyaneza, J., Fisher, T. W., Sengoda, V. G., Garczynski, S. F., Nissinen, A., & Lemmetty, A. (2010).

Association of "*Candidatus* Liberibacter solanacearum" with the Psyllid, *Trioza apicalis* (Hemiptera: Triozidae) in Europe. *Journal of Economic Entomology, 103*, 1060-1070.

Ndankeu, Y. P. M., Tamesse, J. L., Burckhardt, D., & Messi, J. (2011). Biodiversity of jumping plant-lice of the Pslyllidae family (Hemiptera: Psylloidea) from the South Region of Cameroon: Faunistics, phenology and host plants. *Journal of Entomology, 8*, 123-138.

Poole, R. W. (1974). *An introduction to quantitative ecology* (1st ed., p. 525). New York: McGraw Hill.

Rabinovich, J. E. (1980). *Introducion a la ecologia de problaciones animales* (1st ed., p. 313). México, CECSA.

Sá, V. A. (2011). *Comportamento de acasalamento, níveis de infestação e parasitismo de Triozoida limbata Enderlein, 1918 (Hemiptera: Triozidae) em Psidium guajava L. (Myrtaceae)* (Dissertação de Mestrado). Universidade Federal da Grande Dourados, Dourados, Brasil.

Shea, M. M., Dixon, P. M., & Sharitz, R. R. (1993). Size differences, sex ratio, and spatial distribution of male and female Water Tupelo, *Nyssa aquatica* (Nyssaceae). *American Journal of Botany, 80*(1), 26-30.

Southwood, T. R. E. (1978). *Ecological methods* (2nd ed., p. 525). New York: John Wiley & Sons.

Yana, W., Tamesse, J. L., & Burckhardt, D. (2010). Jumping plant-lice of the family Psyllidae Latreille (Hemiptera: Psylloidea) from the Center region of Camerroon: faunistics, phenology and host plants. *Journal of Entomology, 7*, 1-18. http://dx.doi.org/10.3923/je.2010.1.18

Young, L. J., & Young, J. H. (1998). *Statistical ecology: A population perspective* (1st ed., p. 565). Boston: Kluwer Academic Publishers.

Zucareli, V., Bonjovani, M. R., Cavariani, C., & Nakagawa, J. (2009). Tolerância à dessecação e influência do tegumento na germinação de sementes de citrumelo 'swingle' (*Citrus paradisi* MACF X *Poncirus trifoliata* (L) RAF.). *Revista Brasileira de Fruticultura, 31*(1), 291-295. http://dx.doi.org/10.1590/S0100-29452009000100042