SPATIAL DISTRIBUTION OF SUGARCANE SPITTLEBUG, *MAHANARVA FIMBRIOLATA*, IN SUGARCANE FIELDS

By

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Abstract

SUGARCANE spittlebug, *Mahanarva fimbriolata* (Stål) (Hemiptera: Cercopidae), is one of the most important pests of sugarcane in the Central-Southern region of Brazil. Information on its spatial distribution in sugarcane fields is important for the development of sampling plans, aimed at their application in integrated management programs. We studied the spatial distribution of *M. fimbriolata* in 10 mechanically harvested green cane fields in Catanduva, São Paulo State, Brazil. In each field of 1.41 ha, 150 samples were collected within a rectangular grid measuring 10 × 10.5 m, between 27 December 2007 and 1 November 2008. The Morisita index was significantly > 1 for eight fields, indicating that, in each of these fields, *M. fimbriolata* has an aggregated spatial distribution and this pattern was not affected by the infestation level. In two fields, *M. fimbriolata* occurred at random. Geostatistical analysis allowed the construction of contour maps through kriging interpolation using the spatial dependence expressed in the semivariograms for five fields. For the other three fields where *M. fimbriolata* has aggregated spatial distribution, it was not possible to construct population maps using kriging interpolation because the distance between sampling points was too large to detect spatial dependence. For the cases where the maps could be constructed, the ranges varied from 23 to 55 m and, using this information, we estimated that it was necessary to sample 6 points/ha to adequately estimate the insect population.

Introduction

Sugarcane spittlebug, *Mahanarva fimbriolata* (Stål) (Hemiptera: Cercopidae), is one of the most important pests of sugarcane in the Central-Southern region of Brazil. Besides noticeably reducing stalk productivity, it causes alterations in the quality of the sugarcane, reducing stalk sugar content and increasing fibre content.

Losses also extend to milling processes, because dead and dry stalks resulting from the attack of the pest reduce the milling capacity as stalks are often cracked and deteriorated, and contaminants make sugar recovery difficult and inhibit fermentation (Dinardo-Miranda, 2008).

To develop sampling plans for application in integrated management programs, we need to know this important pest's spatial distribution in sugarcane fields. Thus, we sought to characterise the spatial distribution of M. *fimbriolata* in sugarcane fields to provide guidance for sampling procedures.

Materials and methods

We studied the spatial distribution of *M. fimbriolata* in 10 mechanically harvested green cane fields in Catanduva, São Paulo State, Brazil. In each field of 1.41 ha, 150 samples were collected within a rectangular grid measuring 10 × 10.5 m, between 27 December 2007 and 1 January 2008, when the ratoons were 4–5 months old. Each sample was represented by 2 m of furrow, where nymphs and occasional adults present on the roots were counted. To visualise the insects on the roots, we carefully pushed away the trash from the sugarcane furrow with a wooden stick and removed the insects from the root region, in the subsurface soil layer.

Data were initially analysed by descriptive statistics of mean, standard deviation, coefficient of variation, maximum value, minimum value, skewness and kurtosis. The Morisita index* was calculated in accordance with Bubenicek and Haas (1969). After this, geostatistical analyses were run using semivariograms and kriging interpolation to construct maps.

The semivariogram analyses were conducted using the GEOSTAT software (Vieira *et al.*, 1983). Based on the models fitted to the semivariograms, the jackknifing test was used to verify whether the estimates of semivariogram parameters were adequate and to estimate the number of neighbours that should be used in kriging (Vieira, 2000).

Once the parameters for the model were confirmed and the adequate numbers of neighbours were estimated, values were interpolated for the locations where they were not measured, by the kriging method, using the GEOSTAT software (Vieira *et al.*, 1983). The kriging-estimated values were used in Surfer software (Golden Software, 1999) to construct the maps.

Results and discussion

In all fields, *M. fimbriolata* population presented high coefficient of variation, with great differences between the maximum and the minimum value (Table 1). A similar observation was reported by Dinardo-Miranda *et al.* (2007), who also worked in São Paulo State, with the variety RB855536.

The Morisita index was significantly greater than 1 for eight fields, indicating that in these fields the *M. fimbriolata* has aggregated spatial distribution and this pattern was not affected by the infestation level.

In two fields, *M. fimbriolata* occurred at random. Dinardo-Miranda *et al*. (2007) and Stingel (2005), working in several fields in São Paulo State, observed in all studied areas that *M. fimbriolata* presented aggregated distribution patterns.

Table 1—Statistical parameters and Morisita Index of *Mahanarva fimbriolata* population.

Area	Mean (insects/ 2 m)	Minimum value	Maximum value	Coefficient of variation (%)	Variance	Skewness	Kurtosis	Morisita index	F_0**
1	16.1	0	34	37.6	36.77	– 0.06	1.13	1.08*	2.28
2	15.4	0	31	42.1	42.08	– 0.15	– 0.10	1.11*	2.73
3	5.1	0	24	136.8	48.71	1.06	– 0.15	2.67*	9.55
4	4.5	0	19	124.6	31.57	0.82	– 0.72	2.32*	6.99
5	4.5	0	21	127.7	33.18	0.86	– 0.60	2.40*	7.35
6	2.6	0	13	139.8	13.33	1.01	– 0.45	2.56*	5.10
7	16.2	5	34	27.1	19.24	0.99	1.92	1.02	1.18
8	23.5	0	73	84.1	389.46	0.22	– 0.95	1.66*	16.59
9	24.2	0	35	21.8	27.92	– 1.76	5.40	1.01	1.15
10	47.6	0	100	43.6	431.89	0.15	– 0.90	1.17*	9.06

*Morisita index = Measures the distribution of a field sampling.
* = significant at 5% and ** = Value of F,

Among the 10 calculated semivariograms, those corresponding to areas 1, 4, 7, 8 and 9 exhibited a ‘pure nugget’ effect* (Table 2). In relation to areas 7 and 9, this was because the pest, in these fields, occurred at random, according to the Morisita index.

For the other areas (1, 4 and 8), the distance between sampling points was too large to allow the detection of a spatial dependence between them.

Table 2—Parameters of fitted semivariograms and of jack knifing, coefficients of determination (r^2), ratio $C_0/(C_0+C_1)$ of *Mahanarva fimbriolata* populations.

Area	Semivariogram parameters			Jack knifing parameters (reduced errors)		r^2	$C_0/(C_0+C_1)$	Area[1] (m^2)
	C_0	C_1	a (m)	mean	variance			
1	Pure nugget effect							
2	25	20	55	– 0.0092	0.9310	0.63	0.56	9.503
3	10	40	32	0.0019	1.0508	0.56	0.20	3.217
4	Pure nugget effect							
5	20	11	50	0.0027	1.0100	0.44	0.58	7.853
6	8	5.4	40	0.0029	1.0080	0.39	0.60	5.027
7	Pure nugget effect							
8	Pure nugget effect							
9	Pure nugget effect							
10	8	27	23	0.0010	0.9585	0.25	0.23	1.662

[1] Area calculated by Πr^2, where Π = 3.1416 and r = a.
Pure nugget' effect – Value of semivariance when the null distance.

The spherical model was best fitted to the semivariograms of data for areas 2, 3, 5, 6 and 10 (Figure 1, Table 2). Although the r^2 values were low, the parameters estimated for the spherical model (C_0, C1, a) were endorsed by the jack knifing test, since the mean values for the reduced errors were near zero and the values for the variance of reduced errors were near 1 (Table 2). Maps showing the spatial distribution of the insects in areas 2, 3, 5, 6 and 7 are shown in Figure 2.

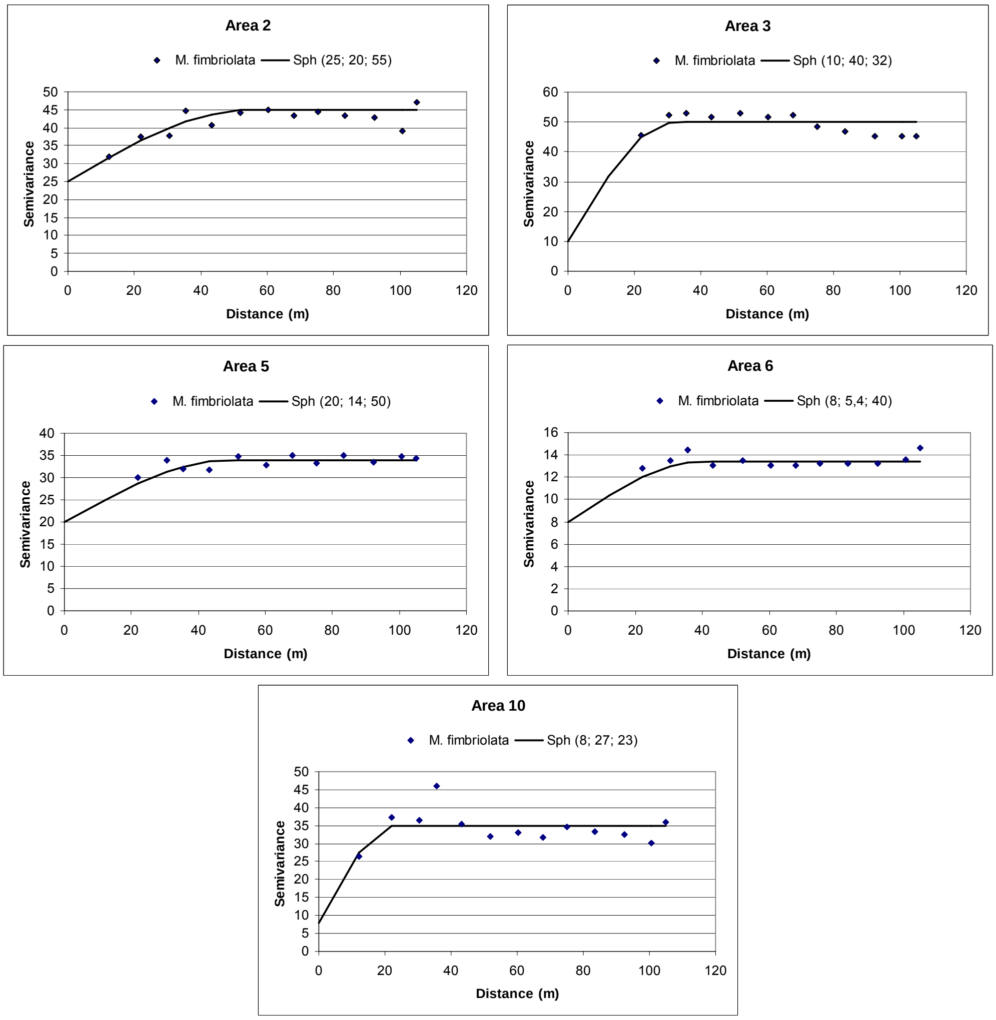

Fig. 1—Semivariograms for populations of *Mahanarva fimbriolata* in areas 2, 3, 5, 6 and 10. Numbers in parenthesis are nugget effect value (C_0), C_1 and range (a) of spherical model (Sph).

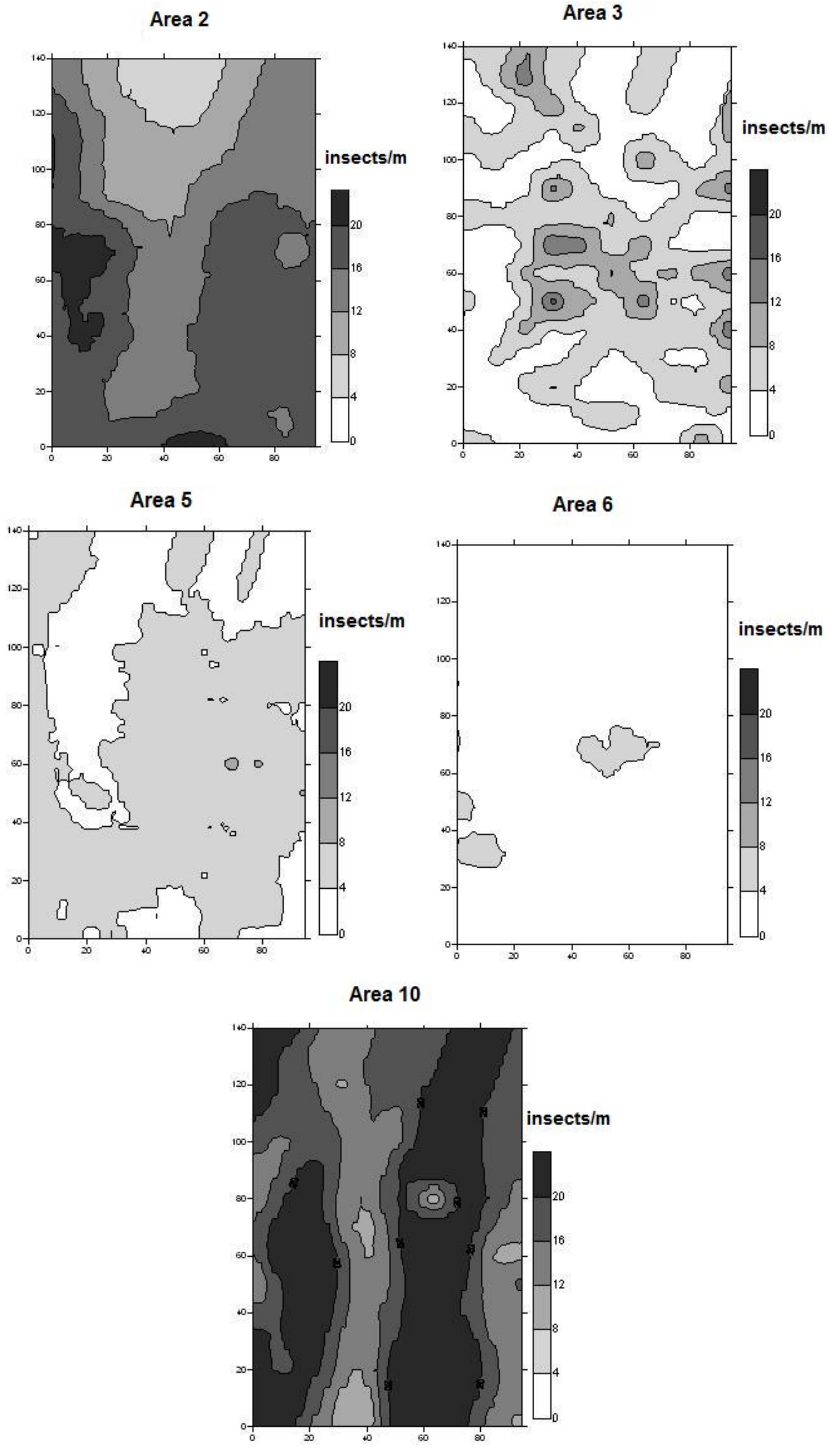

Fig. 2—Maps of the spatial distribution of populations of *Mahanarva fimbriolata* in areas 2, 3, 5, 6 and 10.

The portion of variability attributed to spatial dependence, given by the $C_0/(C_0+ C_1)$ ratio, ranged from 0.20 to 0.60 (Table 2), indicating a strong or a moderate spatial dependence among samples (Cambardella *et al.*, 1994). The range (a), representing the distance at which there is spatial dependence between samples, varied from 23 to 55 m. These data allowed us to estimate that the spittlebug aggregation area ($A = \Pi r^2$, where $r = a$), in these fields, varied from 1.662 m^2 to

9.503 m^2, suggesting that 6 and 1 sampling points per hectare would be necessary to obtain a reliable estimate for the pest population in areas 10 and 2, respectively.

Dinardo-Miranda *et al*. (2007), working with *M. fimbriolata* in sugarcane fields, also found moderate spatial dependence among samples. In that study, the ranges varied from 33 to 56 m allowing those authors to conclude that it was necessary to sample 3 points/ha to adequately estimate the insect population. Using this information, we estimated that it was necessary to sample 6 points/ha to adequately estimate the insect population.

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DISTRIBUTION SPATIALE DE LA CICADELLE ÉCUMEUSE DE LA CANNE SUCRE, *MAHANARVA FIMBRIOLATA*, DANS LES CHAMPS DE CANNE À SUCRE

Par

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MOTS CLÉS: *Saccharum*, Canne à Sucre, Ravageurs, Échantillonnage, Cicadelle Écumeuse.

Résumé

LA CICADELLE écumeuse de la canne à sucre, *Mahanarva fimbriolata* (Stål) (Hemiptera: Cercopidae), est un des plus importants ravageurs de la région méridionale-sud du Brésil. Les informations sur sa distribution spatiale dans les champs de canne à sucre sont importantes pour l'élaboration des plans de sondages et leur utilisation dans les programmes de gestion intégrée. Nous avons étudié la distribution spatiale de *M. fimbriolata* dans 10 champs recoltés mécaniquement en vert à Catanduva, État de São Paulo au Brésil. Pour chaque champ de 1.41 ha, 150 échantillons ont été prélevés à l'intérieur d'une grille rectangulaire de 10 × 10.5 m, entre le 27 décembre 2007 et 1er novembre 2008. L'index de Morisita était significativement supérieur à 1 pour huit champs, démontrant que *M. fimbriolata* avait une distribution spatiale agrégée dans chacun de ces champs et cette tendance n'était pas affectée par le niveau d'infestation. Dans deux champs, la distribution de *M. fimbriolata* était aléatoire. Une analyse géostatistique a permis l'élaboration des cartes hypsométriques par interpolation par krigeage. La dépendance spatiale exprimée en semivariogrammes a été utilisée pour cinq champs. Pour les trois autres champs, où la distribution spatiale de *M. fimbriolata* était agrégée, il n'a pas été possible d'établir des cartes de population en utilisant l'interpolation par krigeage, l'écart entre les points de prélèvement étant trop grand pour détecter la dépendance spatiale. Pour les cas où les cartes pouvaient être construites, la distance a varié de 23 à 55 m. En utilisant cette information, nous avons considéré qu'il est nécessaire d'échantillonner six points par hectare pour une estimation plus précise de la population de l'insecte.

DISTRIBUCIÓN ESPECIAL DEL SALIVAZO DE LA CAÑA, *MAHANARVA FIMBRIOLATA*, EN CAMPOS DE CAÑA DE AZÚCAR

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PALABRAS CLAVE: *Saccharum*, Caña de Azúcar, Plagas, Muestreos, Salivazo.

Resumen

EL SALIVAZO de la caña de azúcar, *Mahanarva fimbriolata* (Stal) (Hemiptera: Cercopidae), es una de las plagas más importantes de la caña de azúcar en la región Centro-Sur del Brasil. La información sobre su distribución espacial en los campos de caña de azúcar es importante para el desarrollo de muestreo, con miras a su aplicación en programas de manejo integral. Por tanto, se estudió la distribución espacial de *M. fimbriolata* en 10 campos de caña cosechada mecánicamente en verde en Catanduva, estado de San Pablo, Brasil. En cada campo de 1.41 hectáreas, se tomaron 150 muestras en una cuadrícula rectangular de 10 × 10.5 m, entre el 27 de diciembre de 2007 y 1 de noviembre 2008. El índice de Morisita de significativamente superior a 1, ocurrió en ocho campos, lo que indicó que en cada uno de esos campos *M. fimbriolata* tuvo una distribución espacial agrupada y por tanto el patrón no se vio afectado por el nivel de infestación. En dos de esos campos, la presencia de *M. fimbriolata* fue al azar. El análisis geoestadístico facilitó la construcción de mapas de contorno a través de la interpolación de Kriging en cinco campos, utilizando la dependencia espacial expresada en semivariogramas. Para los otros tres campos en los que *M. fimbriolata* tuvo una distribución espacial agrupada, no fue posible la construcción de mapas de población mediante la interpolación de Kriging porque la distancia entre los puntos de muestreo era demasiado grande para detectar la dependencia espacial. Para los casos en que los mapas se pudieron construir, las gamas de variación estuvieron entre 23 hasta 55 metros y, con esta información, se estimó que era necesario tomar muestras de 6 puntos/ha para una estimación adecuada de la población de insectos.