

DATOS ECOLÓGICOS DE *BEMISIA TABACI* GENNADIUS (HOMOPTERA: ALEYRODIDAE) EN TRES CULTIVOS HORTÍCOLAS EN EL SUR DE LA PROVINCIA DE GRANMA, EN CUBA

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RESUMEN

Se analizaron datos ecológicos de *Bemisia tabaci* Gennadius en el sur de la provincia de Granma, Cuba, desde 1993 hasta el 2001. Los promedios anuales y mensuales de distribución e intensidad de ataque de la plaga en tres cultivos hortícolas se correlacionaron con las áreas sembradas y variables climáticas en análisis de regresión lineal simples y múltiples. A pesar de tener la menor área cultivada, la relación área-plaga fue significativa en tomate, lo que demuestra su importancia como la principal planta hospedante en estos agroecosistemas. Las diferencias fueron estadísticamente significativas entre años para un mismo cultivo. Al agrupar todos los factores climáticos analizados se explican entre 43 y 52% de la afectación en tomate y frijol, pero solo 24% en calabaza. Las correlaciones más elevadas (> 55%) se alcanzaron al agregar área sembrada y distribución a los factores climáticos como variables independientes, y mantener la intensidad de ataque como variable dependiente. Se discute la importancia de estos resultados para el pronóstico de la plaga en la región.

Palabras clave: *Bemisia tabaci*, ecología, tomate, frijol, calabaza

ABSTRACT

Ecological data about *Bemisia tabaci* Gennadius in southern Granma province, Cuba from 1993 to 2001 were analyzed. Yearly and monthly averages of distribution and affectation intensity of the pest on three horticultural crops were correlated with sown area and weather factors in simple and multiple lineal regressions. In spite tomatoes had the smallest cultivated area; the relationships between sown area and the pest were significant, showing its importance as the major host plant in these agroecosystems. Differences were statistically significant between years for each single crop. All the weather factors together explained 43 and 52% of affectation for tomatoes and beans, but only 24% for squash. The highest correlations (> 55%) resulted in the analyses when sown area and distribution were added as independent variables to the weather factors, keeping affectation as the dependent variable. It is discussed the importance of these results for pest forecasting in the region.

Key words: *Bemisia tabaci*, ecology, tomato, bean, squash

INTRODUCTION

Sweetpotato whitefly (*Bemisia tabaci* Gennadius. Homoptera: Aleyrodidae) is one of the most dangerous pests in Latin America because its capacity for transmitting geminiviruses [Hilje & Arboleda, 1993; FAO, 1994; Zamora *et al.*, 2001; Domínguez, *et al.*, 2001; Vázquez *et al.*, 2001]. It has been the most important pest for most of the horticultural crops in Cuba since 1989 [Vázquez & Murguido, 1997; Vázquez, 1995; Murguido *et al.*, 2001], which started at the western part of the country and then spread very fast to the whole island [González *et al.*, 1997]. In the southern part of Granma the whiteflies had been recorded since 1982, but they only reached the status of major

pest from 1992 onwards [ETPP, 2004; Caballero *et al.*, 2002].

Located at Eastern Cuba, Granma province covers an area of 8 372 km² and is mainly dedicated to agriculture especially rice, sugar cane, coffee, tomatoes, beans and maize [CEE, 1998]. The Territorial Plant Protection Station (ETPP) of Manzanillo is in the southern part of Granma, and it focuses on five coastal municipalities: Manzanillo, Campechuela, Media Luna, Niquero and Pí-lón, covering 2 763 km² [ETPP, 2004]. This area comprises about one third of the province expanse, and is the driest and warmest part. The present contribution analyses ecological data of *B. tabaci* within the ETPP territory.

MATERIALS AND METHODS

Historical data recorded during nine years (1993-2001) by Plant Protection officers in the area covered by the ETPP of Manzanillo were gathered. Tomato (*Lycopersicon esculentum* Mill) were sown just once a year, starting at the end of a year (mostly October/November) and finishing early the next (mostly March); that is the reason why data were only available for about six months. Used varieties were: Campbell-28, Rosoll, Roma, Lignon, HC 3880, Amalia, and Vyta. The sown area for tomatoes during the studied years was rather uniform, between 22 500 and 33 500 ha, except for 1993 with 13 100 ha.

Both bean (*Phaseolus vulgaris* L.) and squash (*Cucurbita* spp.) were sown throughout the year, usually three and up to four cropping seasons, and data were available for all months. Bean varieties included Lina, INCA LD and Canton 1, with significant difference between the year with the smallest sown area (59 000 ha) and the greatest one (378 000 ha). Squash varieties were Isleña Avileña, Cueto and Sello de Oro [ETPP, 2004], and the sown area extent was increasing during the years, from 50 500 ha in 1993 to 169 000 ha in 2001.

Sampling protocol followed those provided by Cuban Plant Protection Research Institute (INISAV), a common practice country-wide [CNSV, 1984; INISAV, 2000; Murguido, 2000]. 100 plants were randomly selected on each field monthly, and searched for *B. tabaci* adults at three different plant strata (high, medium and low). Affection degree was then classified as 1 (Low, < 1 adult/plant), 2 (Medium, > 1 and < 5) or 3 (High, > 5).

The size of each field was recorded to calculate total area affected by the pest. Two formulas provided by INISAV were used: Distribution percent (%D) and Affection Intensity Index (AII). For %D the sum of fields with any affection was divided by the total number of sown area in the cropping season, providing an estimate of the pest extent in the region. On the other side, AII gives a percent of affection based on the maximum attack level (plants affected at the highest degree). For AII, calculation data were pooled using the following formula:

$$\%AII = \frac{\sum_{i=1}^k a \times b}{k \times N} \times 100$$

where

a = Affection degrees (in this case 1-3, see above),

b = Affected area for each degree

k = Highest degree (3 in this case)

N = Total sampled area

Monthly and yearly values of %D and AII were transformed and correlated with data of temperature (minimum, maximum and middle) and rainfall. Acosta & Álvarez (2000) and CEE (1989) provided weather information of Granma based on three meteorological stations. Statistical analyses were carried out using Statistic for Windows (1993).

RESULTS AND DISCUSSION

The yearly average of distribution (%D) was quite different between crops (*Figure 1*). In the ten years studied average for tomatoes areas ($42.4 \pm 23.1\%$) was far higher than the others crops – twice the average of beans ($21.3 \pm 11.1\%$) and almost five times that of squash ($9.1 \pm 11.8\%$), and the differences were statistically significant ($F = 9.45$; $p < 0.001$). Beans figure was twice that of squash but differences were not significant, probably due to the high values of the standard deviation. However, it was otherwise expected taking into account the normal fluctuations of the pest populations during the year.

The yearly average for affection (AII) had the same pattern (*Figure 2*). The ten-year value for tomatoes (23.4 ± 7.6) was significant higher ($F = 13.74$; $p < 0.0001$) showing a severe attack. Differences between beans (8.1 ± 6.2) and squash (4.9 ± 9.0) were not statistically significant, and the attack level was lower. These results are in agreement with those of other Cuban researches on *Bemisia* [e.g. Machado *et al.*, 1997, 1998 & 2001; González, 2001; Martínez, 2001; Murguido *et al.*, 2001; Vázquez, 1991, 1995 & 2003].

The monthly %D values for tomatoes showed a first peak in October/November for six of eight analyzed years, followed in most cases by a second one in March/April (*Figure 3*). An extra peak was recorded between (January/February) in the last two cropping seasons. Regarding the AII monthly values, a first peak was reached between October and December in six of the eight years, and a second one in January/February (except for March of the 1997/98 cropping season). However, only one of the two peaks was recorded in a half of the years.

Machado *et al.* (1997, 1998) found a rather similar pattern in the northern part of Granma, with higher values of infestation in the driest months (November-March). An exception was Cauto Cristo municipality [Machado *et al.*, 2001], where pest diminished its populations only at the end of the cropping season (March). On the other hand, Vázquez (1995) and González (1997) provided elements about *Bemisia* infestations in early plantings of tomatoes at nation level (i.e. September) and its influence on the latter months of the cropping season.

As for beans, there was no record of *Bemisia* during 1994. Monthly data for %D show that in almost two thirds of the other years the pest reached a peak of maximum distribution between January and March, mainly in March (Figure 4). A second peak was recorded in May/June (mostly in June), but in three out of eight years this peak was absent. A third and last peak was reached in September/October, except for one year where it was reached as late as January of the next year. Regarding the AII monthly values, a first peak was reached in February/March, a second one in June (but in one year it was reached as late as August, and in two years it was absent), and a third one in September-November (but absent in two out of eight years).

These results are in agreement with those of Machado *et al.* (2001) and Toledo (2002) for other regions of Granma province. For beans, Vázquez (1991) and Mateo *et al.* (1997) reported higher levels of *Bemisia* at the beginning of the plantings in Cuba. Vázquez (1995) also found in Western Cuba fields with two peaks of infestation on June-August and September-November, which correspond with the second and third peaks found in the present study.

%D monthly values for squash were higher at the beginning (February/April) and at the end (September/December) of the years; but in the two first years analyzed there was not pest at all, and in other two there was only a maximum in the middle of the years (Figure 5). Monthly AII values were similar with a first peak in March/May, a second one between August and November, the first two years had no infection, and two years (1998 and 1999) only had a maximum in the middle of the year. In general, the pest was far less important than in the other crops.

Monthly data of %D and AII significantly correlated in all cases, but values of R^2 coefficients were quite

different between each crop (Table 1). Distribution explained almost half of the variation of AII in squash but only one third in tomatoes and just 0.12 in beans. This means that for tomatoes and beans other factors are more important in the ecology and behavior of the pest and its damage to these crops.

Relationship between sown area and the pest was not significant for beans and squash, and R^2 values were low (Table 1). The extents of areas devoted to these crops seems to be not a major factor explaining the ecology of *Bemisia*. On the other hand, and even though tomatoes had the smallest area of all studied crops, sown area significantly accounted for 12% of the whitefly distribution and for 29% of the affectation intensity. This result is remarkable as it shows the importance of tomato as the major host plant for the pest in the region, in spite of its cropping season lasting just half of the year.

Influences of weather conditions on whitefly populations were clearer, but not significant in all cases (Table 1). Monthly values of rainfall and average temperature do not have much influence on both %D and AII (except for rainfall-AII in tomatoes). Maximum temperature had a significant influence on tomatoes and beans – R^2 between 0.27 and 0.30– but not in squash. Minimum temperature was only significant for tomatoes ($R^2 = 0.35$).

Results considering temperature agreed with the statements of Vázquez (1991) about *Bemisia* ecology in Cuba. As for rainfall, results are not so similar though, because that author found a relatively strong negative relationship between rainfall and whitefly populations while in this work it has found the same effect rather weak from the statistical point of view (see below).

Results show that when weather factors are analyzed separately, pest distribution in the crops does not seem to correlate well. But, if all variables are put together, then they are able to account for 43 and 52% of the AII for tomatoes and beans –although just 24% for squash. They also accounted for 44 and 23% of the pest distribution in the crop for tomatoes and beans respectively (Table 1). If weather, area and %D are enclosed in one analysis as independent variables (AII as the dependent one) regression results show the highest and more significant correlations of all (R^2 between 0.43 for squash and 0.69 for beans).

Table 1: Simple and multiple regressions results for all encompassed variables in tomato, bean and squash (annual values). Southwestern Granma province, 1993-2001

Dependent Variables	Independent Variables	R ² Values		
		Tomato	Bean	Squash
AII	%D	0.33 *	0.12 *	0.45 *
AII	Area	0.29 *	0.07 *	0.0001 ns
AII	Rainfall	0.07 *	0.10 ns	0.04 ns
AII	Average Temperature	0.17 *	0.0003 ns	0.10 ns
AII	Maximum Temperature	0.27 *	0.30 *	0.10 ns
AII	Minimum Temperature	0.35 *	0.07 ns	0.15 ns
AII	Area, Rainfall	0.27 *	0.10 *	0.04 ns
AII	Area, Rainfall, % D	0.43 *	0.20 *	0.47 *
AII	Average, Maximum, Minimum Temp.	0.40 *	0.52 *	0.23 ns
AII	Rainfall, Average, Maximum, Minimum Temp.	0.43 ns	0.52 *	0.24 ns
AII	Area, Rainfall, Average, Maximum, Minimum Temp.	0.49 ns	0.55 *	0.32 ns
AII	% D, Area, Rainfall, Average, Maximum, Minimum Temp.	0.55 *	0.69 *	0.43 ns
% D	Area	0.12 *	0.01 ns	0.06 ns
% D	Rainfall	0.03 ns	0.001 ns	0.07 ns
% D	Average Temperature	0.01 ns	0.004 ns	0.01 ns
% D	Maximum Temperature	0.16 ns	0.13 *	0.001 ns
% D	Minimum Temperature	0.14 ns	0.002 ns	0.04 ns
% D	Area, Rainfall	0.09 ns	0.01 ns	0.01 ns
% D	Average, Maximum, Minimum Temp.	0.43 *	0.23 *	0.11 ns
% D	Rainfall, Average, Maximum, Minimum Temp.	0.44 ns	0.23 *	0.11 ns
% D	Area, Rainfall, Average, Maximum, Minimum Temp.	0.46 ns	0.24 ns	0.39 ns
AII, % D	Area	0.12 *	0.01 ns	0.06 ns
AII, % D	Area, Rainfall, Average, Maximum, Minimum Temp.	0.46 ns	0.24 ns	0.39 ns

Values marked with an asterisk and in bold are statistically significant ($p < 0.05$). ns = no significant.

However, pest-weather relationships found in this study, as well as the other references here cited [Vázquez, 1995], must be seen with caution. Monthly values can obscure finer relationships between pest populations and some of climatic variables. For example: it has been shown that heavy rains in the early rainy season are able to diminish populations of *Bemisia* because of a washing effect [e.g. Vázquez, 1991]. At present, rainfall data are only available on a monthly base, so it is impossible to assess the influence of heavy rains with current

information. With variability of temperature within a day happens similar, and again the weather data are too coarse for precise analysis. Other constraint is that weather data are gathered from three meteorological stations –the only available in the province, and may not represent the variability in the all southern Granma.

On the other hand the present study is based on comprehensive information from a rather large area, including dozens of fields, and during ten continuous

years. Dry, wet and average years were covered in the analysis, and the variability found was high at all levels. Regression analyses allowed making scientific-based, statistically-supported inferences about pest ecology, and a rather clear pattern emerged in all ETTP areas. Most of the others Cuban papers cited here were based on few fields sampled for less than three years –usually one field for one year-, and sometimes they were also able to find differences based on its scale.

Within the context of a Plant Protection Station, looking to provide advices to local farmers about pests, it is neither possible nor necessary to carry out a more detailed field-based study, but just to get a general pattern at the region level. Present data show that even at this rather coarse, large and diverse level some statistically significant relationships can be found, which in turn can be applied to the development of forecasting systems [González, 2005].

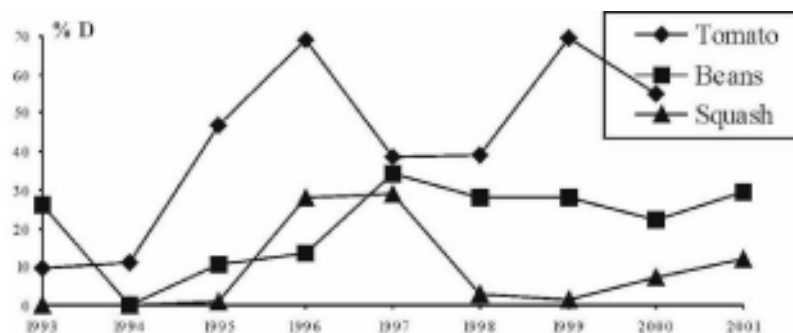


Figure 1. Yearly averages of Distribution (% D) in tomato, bean and squash, southern Granma province (1993-2001). Ten-year values for each crop ($\pm$ standard deviation) are shown in the right of the graph. Values followed by different letters were statistically different.

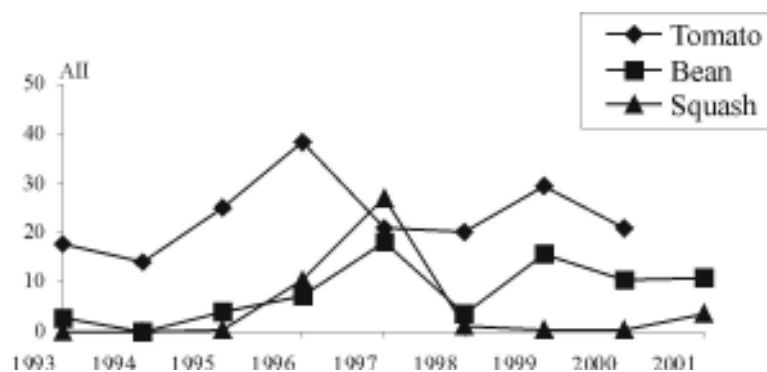


Figure 2. Yearly averages of Affection Intensity Index (All) in tomato, bean and squash, southern Granma province (1993-2001). Ten-year values for each crop ($\pm$ standard deviation) are shown in the right of the graph. Values followed by different letters were statistically different.

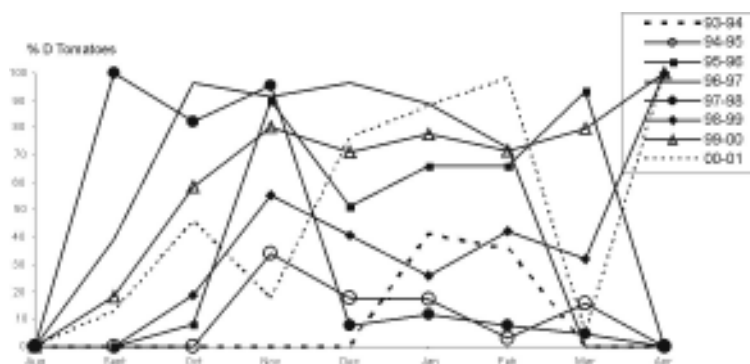


Figure 3. Monthly values of Distribution (% D) in tomato, southern Granma province (1993-2001).

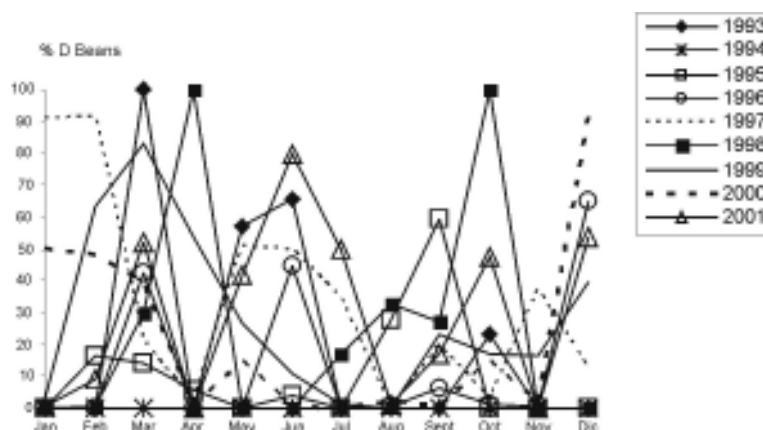


Figure 4. Monthly values of Distribution (% D) in beans, southern Granma province (1993-2001).

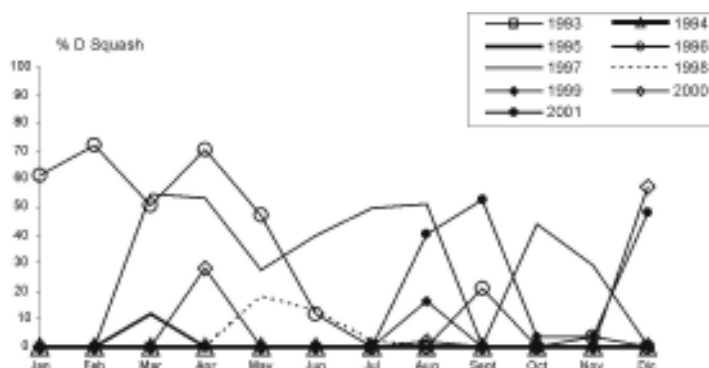


Figure 5. Monthly values of Distribution (% D) in squash, southern Granma province (1993-2001).

CONCLUSIONS

- Yearly and monthly values of distribution and affectation intensity for *Bemisia* spp. in three horticultural crops showed, correlation with weather factors as well as sown area, although results were different between years and crops.
- The highest correlations were reached when sown area, distribution and all of the weather factors were pooled as independent variables, keeping affectation as the dependent variable.
- These analyses could be used for pest forecasting in the region in the future.

REFERENCES

- Acosta, T.; P. Álvarez: «Influencia climática en la ecología de plagas en el cultivo del maíz», Informe del Centro Provincial de Meteorología, CITMA, Bayamo, Granma, Cuba, 2000.
- Caballero, J.; A. Verdecia; R. Alarcón: «Análisis histórico de la incidencia de *Bemisia* sp. y Geminivirus del tomate en el territorio de la Estación de Protección de Plantas de Manzanillo», Encuentro de Agricultura Orgánica, Granma, ACTAF, 3-4 de noviembre, 2002.
- Comité Estatal de Estadística: *Anuario Estadístico de Cuba*, 1988.
- Centro Nacional de Sanidad Vegetal: «Registro territorial histórico. Bioestadística», Señalización y Pronóstico, La Habana, 1984.
- Domínguez, M.; R. Crespo; D. Cruz: «Presencia de la mosca blanca (*Bemisia tabaci*) en un policultivo tabaco-tomate y su relación con el virus del encrespamiento foliar amarillo del tomate (TYLCV)», IX Taller Iberoamericano y del Caribe sobre Moscas Blancas y Geminivirus, Resúmenes. Impresos Plaza América, Varadero, Cuba, julio de 2001.
- Estación de Protección de Plantas: «Información bioestadística de la Estación de Protección de Plantas», Manzanillo, Granma, Cuba, 2004.
- FAO: «Informe Regional sobre Tecnologías Integradas de Producción y Protección de Hortalizas», Cuernavaca, México, 1994.
- González, G.: «Los geminivirus en los cultivos agrícolas de Cuba», III Seminario Científico Internacional de Sanidad Vegetal, La Habana, junio de 1997, p. 97.

- González G.: «Aspectos epidemiológicos de la relación begomovirus-mosca blanca en el cultivo del tomate en Cuba», Resúmenes IV Seminario Científico de Sanidad Vegetal, 10-14 de junio, La Habana, 2001, p. 218.
- González, M.; J. Muñoz; A. Mateo; S. Reyes; N. Pérez *et al.*: «Manejo integrado del complejo mosca blanca-mosaico dorado en frijol (*Phaseolus vulgaris*) en Cuba», III Seminario Científico Internacional de Sanidad Vegetal, La Habana, junio de 1997.
- González, M.: «Ecología y manejo de *Bemisia* spp. en la ETPP de Manzanillo», Thesis of Master Science, Universidad de Granma, Cuba, 2005.
- Hilge, L.; O. Arboleda: «Las moscas blancas (Homoptera: Aleyrodidae) en América Central y el Caribe», CATIE, Serie Técnica, Informe Técnico no. 205, 1993.
- Instituto de Investigación de Sanidad Vegetal: *Resumen de metodologías de señalización*, La Habana, 2000.
- Machado, J.; M. Fonseca; D. Bruqueta; J. Pérez; C. Tornos; E. Suárez; R. Blayas: «Comportamiento de *Bemisia* sp. como plaga del tomate y vector del virus del encrespamiento amarillo de las hojas del tomate en dos agroecosistemas de la región del Cauto», III Seminario Científico Internacional de Sanidad Vegetal, La Habana, junio de 1997.
- Machado, J.; D. Bruqueta; J. Pérez; C. Tornos: «Comportamiento de *Bemisia* spp. y el virus (TYLCV) en seis agroecosistemas de la región del valle del Cauto», VI Simposio Internacional de Sanidad Vegetal en la Agricultura Tropical, Santa Clara, Cuba, mayo de 1998.
- Machado, J.; M. Fonseca; A. Puertas; D. Bruqueta; J. Pérez; C. Tornos; J. Fernández; C. Guerrero; M. Castellá; L. Sueiro; M. A. Fonseca; E. González: «Informe técnico del Comité de Expertos Territorial del Programa de Producción de Alimentos por Vías Sostenibles», CITMA, Bayamo, Granma, Cuba, 2001.
- Mateo, A.; S. Reyes; M. González: «Ciclo biológico de *Bemisia tabaci* (Gennadius) en tres cultivos hospedantes y dinámica poblacional de la plaga en el frijol», III Seminario Científico Internacional de Sanidad Vegetal, La Habana, junio de 1997.
- Martínez, M.: «Programa de sanidad vegetal contra plagas emergentes en Cuba», IV Seminario Científico Internacional de Sanidad Vegetal. Taller de Plagas Emergentes, Impresos Plaza América, Varadero, Cuba, julio de 2001.
- Murguido, C.: «Manual sobre manejo integrado de plagas, enfermedades y malezas en el cultivo del frijol», PROFRIJOL, INISAV, MINAGRI, La Habana, 2000.
- Murguido, C.; Ana I. Elizondo; M. Neyra; Y. Velásquez; E. Pupo; S. Reyes; J. Rodríguez; C. Toledo: «Manejo integrado de plagas de insectos en el cultivo del frijol», IV Seminario Científico Internacional de Sanidad Vegetal, La Habana, julio de 2001.
- Statistics for Windows: *Release 4.2*, StatSof, Inc., 1993.
- Toledo, C.: «Incidencia de virus y sus vectores en frijol», V Taller Territorial, Granma, Cuba, julio de 2002.
- Vázquez, L.: «Contribución al conocimiento de *Bemisia tabaci* Genn.», *Actualidades de Sanidad Vegetal* 1(2): 11-13, 1991.
- : «Sistema de diagnóstico, inventario y plantas hospedantes de moscas blancas en Cuba», Doctoral thesis, INISAV, La Habana, 1995.
- : «Manejo integrado de plagas. Preguntas y respuestas para extensionistas y agricultores», CIDISAV, INISAV, La Habana, Cuba, 2003.
- Vázquez, L.; C. Murguido: «Problemática actual de las moscas blancas y alternativas para su manejo», III Seminario Científico Internacional de Sanidad Vegetal, La Habana, junio de 1997.
- Vázquez, L.; C. Murguido; G. González: «Enfoque territorial del programa de manejo integrado de la mosca blanca y el Geminivirus en el tomate», X Taller Iberoamericano y del Caribe sobre Moscas Blancas y Geminivirus», Resúmenes, Impreso Plaza América, Varadero, Cuba, julio de 2001.
- Zamora, M.; D. Padilla; A. Sediles; P. Castillo: «Informe de Nicaragua», X Taller Iberoamericano y del Caribe sobre Moscas Blancas y Geminivirus, La Habana, Cuba, julio de 2001.