Some Factors in a Pest Management Program for Valencia Sweet Orange Groves with Citrus Variegated Chlorosis (CVC)

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ABSTRACT. Citrus variegated chlorosis (CVC) known in Argentina as pecosita is caused by *Xylella fastidiosa*. Sharpshooters (Homoptera: Cicadellidae) are considered to be vectors of the disease. The objective of this work is to analyze the behavior of the sharpshooters, and the interaction of different factors such as bacterial hosts in citrus groves with CVC. A survey of natural weeds and sharpshooters was carried out in two Valencia sweet orange plantations in the Montecarlo area with 71% and 55% CVC incidence. Dot immunobinding assays (DIBA) were conducted several times on different weeds and Cicadellidae collected from both locations. In the fall, the symptoms were very severe in the trees and the largest number of CVC positive samples were found in weeds, citrus, and sharpshooters. The largest number of CVC positive samples for sharpshoorters was obtained during the summer and early fall months. The highest index value HTD (Homoptera/trap/day) was also reached at this time. Both HTD and positive samples, were very low during the winter time.

Citrus variegated chlorosis (CVC) is known in Argentina as pecosita and is caused by *Xylella fastidiosa*. Sharpshooters (Homoptera: Cicadellidae) are considered to be the possible vectors of the disease (2). The knowledge of the specific diversity in the ecosystem as well as the factors that interact with them is fundamental for the decision making in IPM.

The Homoptera are caught by means of an entomologic net in the natural vegetation, but the species which inhabit citrus trees were caught by means of sticky yellow traps which allowed us to associate the levels of Homoptera in the grove (3,9). By trapping insects by such means, their populations can be monitored by an index of number of insects collected per trap per day (1).

The serological detection of *X. fastidiosa* by dot immunobinding assay (DIBA) is frequently used in epidemiologic studies of CVC and to test nursery materials for CVC infection.

In relation to the natural enemies, parasitoids play an important role in regulating populations of phytophagous insects. In perennial cultivation like citrus, it is possible to maximize biological control with proper strategies (7).

The control of weeds is another component in the agroecosystem, because they are often alternative hosts and a source of inoculum. Weed management is necessary but must be done in relation to the ecosystem. In citrus plantations in Brazil, management of weeds and populations of Cicadellidae and Cercopidae is accomplished by use of herbicides in the rows and a weed cutter between rows to decrease the amount of vector habitat and, hence, incidence of CVC (4, 5, 10).

The objective of our research reported here is to analyze the population of the different sharpshooters in CVC-affected groves and evaluate their interaction with presence of bacteria in insect and weed species.

MATERIALS AND METHODS

The sharpshooters were obtained from two sweet orange groves with CVC located in Montecarlo, Misiones. The first site was an experimental area of 3 ha in Laharrague and the second was a 2 ha commercial planting. Both were sampled on four dates: February, July, October and November 1995.

An entomological net was used to capture the sharpshooters from natural vegetation, five samples per date and a unit of sample equal to 50 successive strokes of the sweep net. Twenty yellow sticky traps were hung in citrus plants in the northeast sector of trees and at a height of 1.5 m on every row and on the third tree of each row. The insect species in citrus and natural vegetation were analyzed and the natural enemies were identified and counted. The estimate of the population of the Cicadellidae on citrus was calculated based on the index determined as the number of Homoptera per trap per day (HTD) $\times$ 1000.

DIBA was used for the detection of the bacteria *X. fastidiosa* in both sharpshooters and in weeds following the methods described by Lee et al. (7).

The scheme of the possible interactions of the citrus-Cicadellidae-weed complex in four seasons of the year, was done with the information about the Homoptera sharpshooters and weeds that tested positive by the DIBA test.

RESULTS AND DISCUSSION

The Homoptera identified and the proportions trapped corresponds to the following families: 76% Cicadellidae; 10% Membracidae; 8% Cercopidae; and 2% corresponded to the families: Aethalionidae, Flatidae, and Dictyopharidae (Fig. 1). The following members of the Order Strepsiptera, and Family Dryinidae, Order Hymenoptera, were recorded here for the first time on citrus: the species *Bucephalogonia xanthophis*, *Hortensia similis*, *Macugonalia leucomelas*, *Scopogonalia subolivacea*, *Sonesimia grossa*, *Acrogonia flaveoloides*, *Bahita (P.) spiniventris*, *Chlorotettix minimus*, *Stirellus picinus f. elegantulus*.

The HTD indices were calculated at both of these locations (Table 1 and 2). The highest indices of HTD were of the plant hopper species

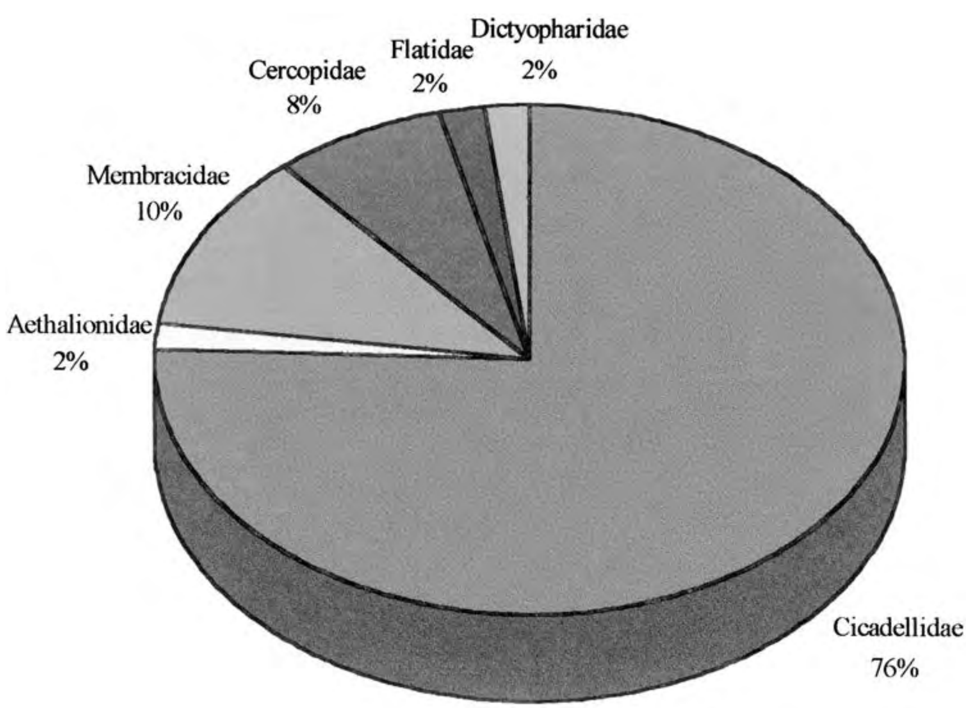

Fig. 1. Relative importance of plant hoppers families in Montecarlo, Misiones.

TABLE 1
INDEX OF HOMOPTERA/TRAP/DAY (HTD) IN LAHARRAGUE, MONTECARLO, MISIONES, 1995

	HTD × 1000										
Homoptera species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
Bucephalogonia xanthophis	2	3	5	8	10	21	7	3	5	15	79
Diedrocephala variegata	15	5	2	5	0	10	5	0	8	2	52
Dilobopterus costalimai	6	5	0	0	0	0	0	0	2	5	18
Macugonalia cavifrons	10	12	6	5	2	16	5	0	8	2	66
Macugonalia leucomelas	0	0	0	2	0	0	5	3	3	0	13
Plesiommata mollicella	2	2	0	0	0	0	0	0	0	0	4
Scopogonalia subolivacea	144	30	29	15	3	26	2	6	0	0	255
Sibovia sagata	2	2	0	0	0	2	13	2	0	0	21
Sonesimia grossa	2	0	0	0	0	2	0	0	0	0	4
Acrogonia flaveoloides	34	83	2	20	7	8	0	0	0	3	157
Molomea consolida	6	2	0	0	0	8	0	0	3	3	22
Oncometopia facialis	0	2	0	0	0	0	2	0	2	2	8
Bahita (P.) spiniventris	6	7	5	0	0	6	0	2	0	8	34
Chlorotettix latocinctus	2	0	0	0	0	0	0	0	0	0	2
Stirellus p. f. elegantulus	0	0	0	0	2	0	0	0	0	0	2
Scaphytopius bolivianus	18	5	5	3	0	2	0	2	3	6	44
Curtara (C.) samera	0	2	0	0	0	0	0	0	0	0	2
Ceresa ustulata	0	0	0	0	0	0	0	0	18	8	26
Entylia carinata	0	0	0	2	0	2	0	3	12	0	19
Totals	249	160	54	60	24	103	39	21	64	54	828

TABLE 2
INDEX OF HOMOPTERA/TRAP/DAY (HTD) IN MR. KÖNIG´S LAND OF CITRUS IN MONTECARLO, MISIONES, 1995

	HTD × 1000										
Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
Bucephalogonia xanthophis	8	3	3	27	17	10	8	3	0	0	79
Diedrocephala variegata	2	0	0	3	2	8	2	2	7	3	29
Dilobopterus costalimai	0	7	3	0	0	8	5	0	10	10	43
Hortensia similis	2	0	3	0	0	0	0	0	0	0	5
Macugonalia cavifrons	5	5	3	7	2	37	3	3	15	24	104
Macugonalia leucomelas	2	0	0	2	2	3	0	0	5	5	19
Rotigonalia limbatula	2	0	0	0	0	0	0	0	0	0	2
Scopogonalia subolivacea	119	10	8	8	18	56	5	18	88	131	461
Sibovia sagata	2	0	0	0	0	8	12	3	27	24	76
Sonesimia grossa	10	0	0	0	0	2	0	0	0	0	12
Acrogonia flaveoloides	71	27	32	20	13	21	2	2	3	0	191
Molomea consolida	2	0	0	0	0	34	2	0	15	11	64
Oncometopia facialis	0	2	0	2	2	23	3	0	5	0	37
Bahita (P.) spiniventris	0	0	0	0	0	3	2	6	0	10	21
Chlorotettix latocinctus	2	2	0	0	0	3	0	0	0	0	7
Scaphytopius bolivianus	10	3	0	2	3	16	2	5	15	74	130
Curtara (C.) samera	0	2	0	2	0	0	0	0	0	0	4
Totals	237	61	52	73	59	232	46	42	190	292	1,284

Scopogonalia subolivacea. The greatest reported index for both groves for *S. subolivacea* was 144 in Laharrague and 119 in the commercial farm, both values were recorded in March (Tables 1 and 2). The spe-

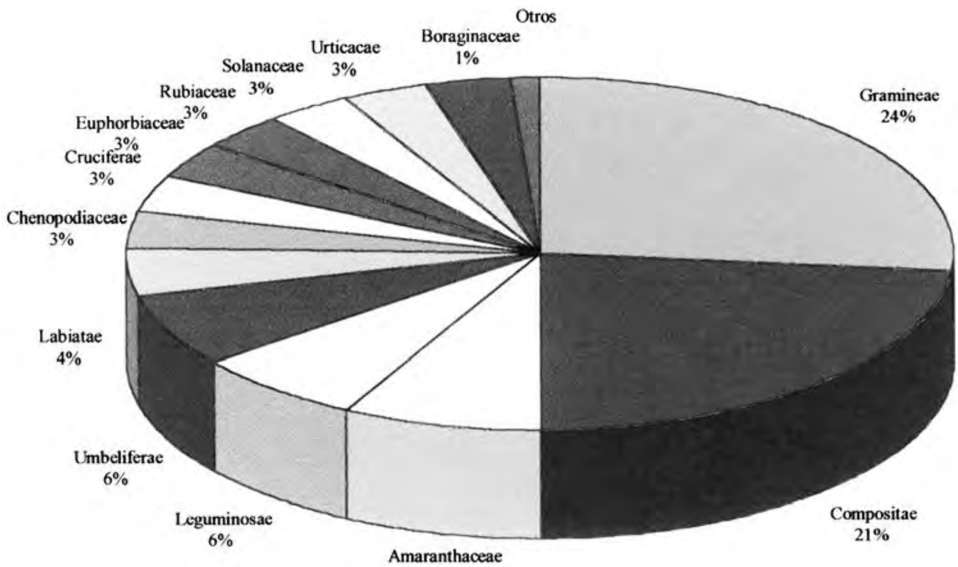

Fig. 2. Percentage of weed species per plant family in two areas of Montecarlo, Misiones, November 1994 to December 1995.

cies *Oncometopia facialis*, *Molomea consolida*, and *Acrogonia flaveoloides* were found in citrus as was previously reported (3) but in low frequency; *Chlorotettix latocinctus* had a HTD of between 2 and 7; and *Scaphytopius bolivianus* had values between 10 and 74.

During summer and autumn, DIBA positives were obtained for *X. fastidiosa* in the plant hoppers. CVC was found in over 19 species of Homoptera at the Laharrague site and in 17 species of Homoptera at the Konig site. Seven species of Cicadellids and two species of the Membracids were identified as reservoirs of *X. fastidiosa*. The number of DIBA positives decreased in winter.

The composition of weeds encountered in the plots were as follows: Gramineae (24%); Compositae (21%); Amaranthaceae (7%); Legumninosae; Umbelliferae (6%); and other families between 1% and 3% (Fig. 2). Weeds such as *Conium maculatum*, *Chloris halophila*, *Digitaria sp.*, *Paspalum regnellii* and *Sida rhombifolia* were found to be reservoirs of the bacteria. They were DIBA positive at different times of the year.

Our results indicated that the citrus-weeds-potential vector complex had the highest level of *X. fastidiosa* positives during autumn. During this period the orange trees show the characteristic symptoms of CVC (Fig. 3).

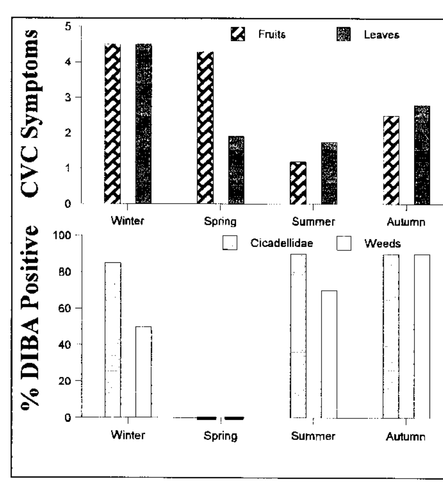

Fig. 3. Scheme of the possible interaction of citrus, weeds and plant hoppers in relation to the presence of *Xylella fastidiosa* of CVC at different times of year in Montecarlo, Misiones.

The seasonal variability of symptoms of CVC in Brazil (8) and the concentration of *Xylella* in blight-affected trees in Florida (6) were of higher intensity at the end of summer and autumn when symptoms were more evident or the number of positive serological samples increased notably. In Misiones, the presence of symptoms in trees affected by CVC are nearly imperceptible after the spring flush is completed.

More confirmation tests for CVC presence in weeds and vectors is needed prior to further analysis of the relation of bacterial populations in weeds and vectors.

LITERATURE CITED

1. Aluja, S. M.
   1993. Manejo integrado de la mosca de la fruta. Trillas, México, 89-120.
2. De Coll, O. R.
   1996. Estudio sistemático y bioecológico de Homopteros Cicadellidos, potenciales vectores de la "Clorosis Variegada de los Cítricos". Thesis Postgrado en Protección Vegetal. Univ. Nac. de La Plata, Buenos Aires. 268 pp.
3. De Coll, O. R., J. P. Agostini, L. W. Timmer, and R. H. Brlansky
   1993. Survey of sharpshoorters in citrus orchards with decline diseases in Misiones, Argentina. In: *Proc. 12th Conf. IOCV*, 320-326. IOCV. Riverside, CA.
4. Feichtenberger, E., M. J. G. Beretta, and R. Harakava
   1994. Manejo integrado das principais doenças fúngicas e bacterianas dos citros. Anais 3º Sem. Intern. de Citros-MIP. Campinas, SP, Fundação Cargill. 291-310.
5. Gravena, S.
   1994. Manejo Integrado de Pragas em citros no Brasil: uma visão atual. Anais 3º Sem. Intern. de Citros-MIP. Campinas, SP, Fundação Cargill. 41-57.
6. Hopkins, D. L., F. W. Bistline, L. W. Russo, and C. M., Thompson
   1991. Seasonal fluctuation in the occurrence of *Xylella fastidiosa* in root and stem extracts from citrus with blight. Plant Dis. 75: 145-147.
7. Lee, R. F., M. J. G. Beretta, K. S. Derrick, and M. E. Hooker
   1992. Development of a serological assay for citrus variegated chlorosis a new disease of citrus in Brazil. Proc. Fla. State Hort. Soc. 105: 32-35.
8. Nasca, A. J.
   1994. Introduccción al Manejo Integrado de problemas fitosanitarios. Parte 1: Agroecología. Serie de la Academia Nacional de Agronomía y Veterinaria, No. 12. 111.
9. Palazzo, D. A.
   1993. Estimativas de perdas de laranja Natal por clorose variegada dos citros. Rev. Laranja, 14: 211-226.
10. Ruesink, W. G. and M. Kogan
    1990. Bases cuantitativas del manejo de plagas: muestreo y medición. In: *Introducción al manejo de plagas de insectos*. R. L. Metcalf y W. H. Luckmann (eds.), 389-435. Limusa, Noriega.