The Great Lakes Entomologist

Volume 21
Number 2 - Summer 1988 *Number 2 - Summer 1988*
Article 3

June 1988

Field Monitoring of X-Disease Leafhopper Vectors (Homoptera: Cicadellidae) and Infected Chokecherry in Michigan Peach and Cherry Orchards

Kirk J. Larsen
Michigan State University

Mark E. Whalon
Michigan State University

FIELD MONITORING OF X-DISEASE LEAFHOPPER VECTORS (HOMOPTERA: CICADELLIDAE) AND INFECTED CHOKECHERRY IN MICHIGAN PEACH AND CHERRY ORCHARDS

Kirk J. Larsen[1] and Mark E. Whalon[2]

ABSTRACT

Populations of leafhopper vectors of X-disease, a major disease problem of the Michigan peach industry, were monitored by yellow sticky board traps and sweepnet samples during 1985 and 1986. Abundance of known leafhopper vectors varied throughout the stone fruit belt of Michigan, with *Paraphlepsius irroratus* common in the southwest Lower Peninsula, but representing 73.1% of all known vectors found. Other commonly found vectors included *Scaphytopius acutus* (22%), *Colladonus clitellarius* (1.5%), and *Norvellina seminuda* (3.4%). Yellow sticky boards were the best monitoring method used, accounting for 90.3% of all vectors captured. The appearance of X-disease symptoms on chokecherry throughout the survey area indicated transmission between wild hosts was occurring in areas where X-disease is not yet a major problem to growers.

X-disease of peach and cherry is caused by a mycoplasmalike organism (MLO) and is vectored by leafhoppers. The X-disease research effort of the current stone fruit decline project requires up-to-date field monitoring of the abundance of X-disease vector leafhoppers and chokecherry. These data are needed to aid in assessing year to year variation in X-disease and leafhopper incidence, evaluating established control procedures and developing new X-disease management strategies.

Past research (Taboada et al. 1975, Rosenberger 1977, Rosenberger and Jones 1978) has demonstrated that at least nine species of leafhoppers that occur in Michigan are vectors of X-disease. *Paraphlepsius irroratus* (Say) is the most common known vector of X-disease in Michigan peach and cherry orchards (Taboada et al. 1975, Rosenberger 1977). It is also the most efficient vector in greenhouse tests (Rosenberger and Jones 1978). Both *P. irroratus* and *Scaphytopius acutus* (Say) are bivoltine in Michigan, with the two periods of adult activity being late June to July and late September to October (Taboada et al. 1975).

Michigan Department of Agriculture (MDA) annual peach surveys (Robinson 1985) indicated the incidence of X-disease has increased in peach orchards of southwest Michigan during the past several years. Chokecherry as an alternate host of X-disease (Gilmer et al. 1954) is considered the major source of X-disease inoculum outside the orchards. For this reason, MDA X-disease regulation No. 612 requires the removal of all chokecherry within 500 ft of peach and cherry orchards.

X-disease is a major peach disease problem in southwestern lower Michigan, but has

[1]Department of Entomology and the Pesticide Research Center, Michigan State University, East Lansing, MI 48824. Current address: Department of Entomology. The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, Ohio 44691.

[2]Department of Entomology and the Pesticide Research Center, Michigan State University, East Lansing, Mich. 48824.

Table 1. List of X-disease sites for the 1985 and 1986 field seasons with fruit type, weather station, and site location data.

Year	Site	County	Fruit	Weather Station	Distance[a] (km)	Coordinates N. Lat.	W. Long.
86	Bainbridge Center	Berrien	Peach	Watervliet	8.0	42° 7′	86° 17′
85	Clarksville	Ionia	Peach	Clarksville	0.0	42° 52′	85° 15′
85	East Lansing	Ingham	Cherry	MSU Hort Farm	1.6	42° 41′	84° 30′
85,86	Fennville	Allegan	Peach	Fennville	0.0	42° 36′	86° 9′
85	Hartford	Van Buren	Peach	Watervliet	5.6	42° 14′	86° 10′
85,86	Lawrence	Van Buren	Peach	Paw Paw	6.4	42° 12′	86° 4′
86	Manistee	Manistee	Cherry	Bear Lake	4.8	44° 19′	86° 14′
86	Northport	Leelanau	Peach	Lk. Leelanau	8.0	45° 6′	85° 38′
86	Walkerville	Oceana	Cherry	Mears	13.5	43° 43′	86° 10′

[a]Distance (km) between site and weather station.

not been a severe problem north of Kent County. Many factors may be limiting the distribution of X-disease. Past monitoring of X-disease in Michigan (Taboada et al. 1975, Rosenberger 1977, Mowry 1982) has not been done north of the Peach Ridge area of Kent County on a regular basis. About 58% of Michigan's peach acreage is located in Berrien and Van Buren counties (Fedewa and Pscodna 1982), and these are the counties hardest hit by X-disease (Robinson 1985).

The leafhopper monitoring reported here was a survey of the entire southern Michigan stone fruit belt. The objectives of this survey were to determine how the abundance and distribution of X-disease vector leafhoppers and symptoms on chokecherry differ temporally and spatially throughout the west coast of Michigan.

MATERIALS AND METHODS

Field Season and Research Sites: During the 1985 and 1986 field seasons, traps were placed in the field during the first week of May. Monitoring occurred weekly in 1985 and biweekly in 1986 and ended ca. 15 November after several hard frosts and the first snow.

Five sites located in Michigan's Lower Peninsula were monitored in 1985 and six sites in 1986 (Table 1). Weather data such as temperature and the resulting degree day accumulations for each site were obtained from the Michigan State University Cooperative Crop Monitoring Service (CCMS) using agricultural weather observation stations located at or near each field site.

Survey of Chokecherry Exhibiting Symptoms: The abundance of wild sources of X-disease inoculum in Michigan was surveyed by biweekly monitoring of chokecherry. In 1986, an 8-km route leaving each field site along two lane roadways was selected and all chokecherry clumps or individual bushes observed exhibiting X-disease symptoms were counted. The average number of infected chokecherry/km was then calculated for each site.

X-disease Vector Leafhopper Survey: The abundance and distribution of known X-disease vector leafhoppers were monitored. In 1985, monitoring was performed weekly at the Lawrence, Hartford, Fennville, Clarksville, and East Lansing sites. In 1986, monitoring was performed biweekly at the Lawrence, Bainbridge Center, Fennville, Walkerville, Manistee, and Northport sites.

Monitoring was performed with yellow sticky board traps and by sweep net sampling. Six yellow sticky board traps were hung at each site ca. 1.5 m above the orchard

groundcover. The traps were 12.5 × 25 cm made of 0.25 in plywood and painted with sun yellow enamel and coated with Tree Tanglefoot®. These traps were replaced on each visit to the site and returned to the lab for examination and removal of captured leafhoppers. Sweep net samples were taken from different areas in and around each orchard site. Four sweep samples were taken, each consisting of 25 sweeps with a 37.5 cm diameter net. Each sweep was ca. a 1.5 m pass through the groundcover foliage. The sweep samples were deposited in plastic bags, placed in a cooler for transport back to the laboratory, and then frozen at −20°C in the lab to kill all insects. Sorting, leafhopper identification to species, and counts of abundance and sex took place in the laboratory.

RESULTS

Field Season: During 1985, temperature effects as measured by degree day accumulations (Baskerville and Emin 1969) were similar at all sites (Fig. 1). The 1986 total accumulations are similar to the 1985 total accumulations for both the Lawrence and Fennville sites. Generally higher temperatures were experienced in both mid-July and early October of 1986. The difference in total degree day accumulation between the Northport (1820 DD) and Lawrence (2585 DD) sites was dramatic, where an average accumulated difference of 765 DD was realized. Average accumulated degree days showed a 478 DD difference between the average of northwestern (1980 DD) and southwestern (2458 DD) weather stations.

Survey of Chokecherry Exhibiting Symptoms: During 1986, chokecherry exhibiting symptoms of X-disease was first observed in southwestern Lower Michigan in late-June and in northwestern Lower Michigan in mid-July. By early September, up to six infected chokecherry/km were visually evident. This delay in symptom expression between southwest and northwest is similiar to the mean degree day accumulation for those areas.

X-disease Vector Leafhopper Survey Leafhopper populations were about five times greater in 1985 than in 1986. Although the generations peaked at different dates in 1985 and 1986, the peaks did occur at approximately the same number of accumulated degree days (Fig. 2). Differences in X-disease vector leafhopper density occurred both between field sites ($T = 2.06$; $df = 24$; $P = 0.05$) and between 1985 and 1986 field seasons ($F = 75.89$; $df = 1,4$; $P < 0.05$).

Representatives of all leafhopper species known to vector X-disease in Michigan were found during both the 1985 and 1986 field seasons. Only four of these, *P. irroratus*, *S. acutus*, *Colladonus clitellarius* (Say), and *Norvellina seminuda* (Say) were present in numbers greater than 1% of all the known vector leafhoppers captured (Table 2). The relative abundance of these leafhoppers in the field during 1985 and 1986 was *P. irroratus* 73.1%, *S. acutus* 22.0%, *C. clitellarius* 1.5%, and *N. seminuda* 3.4%.

Some sites supported larger populations of these vectors than others (Table 3). *P. irroratus* was very common in the East Lansing, Lawrence, Hartford, and Fennville sites. *S. acutus* was found easily at the Hartford site and in good numbers in Lawrence and Fennville. *C. clitellarius* was found most commonly at the Manistee site, while *N. seminuda* was found easily in East Lansing and often in Fennville, but was not found at or north of Walkerville.

Yellow sticky board traps captured 90.3% of all known X-disease vector leafhoppers captured during 1985 and 1986. There was no significant difference in this monitoring method capture rate between the two generations ($F = 2.784$; $df = 1,9$; $P \geq 0.05$). The sex ratio of *P. irroratus* leafhoppers did not significantly differ between the yellow board trap and sweep net monitoring methods, with male leafhoppers accounting for 65% of the captures on yellow sticky board traps, and 42% of the captures in sweep nets. There was no significant difference in this captured leafhopper sex ratio between the two generations ($F = 1.093$; $df = 1,9$; $P \geq 0.05$).

DISCUSSION

The similarity of the degree day accumulations during 1985 was due to the concentration of all 1985 field sites in the southwestern and central Lower Peninsula. The 1986 sites

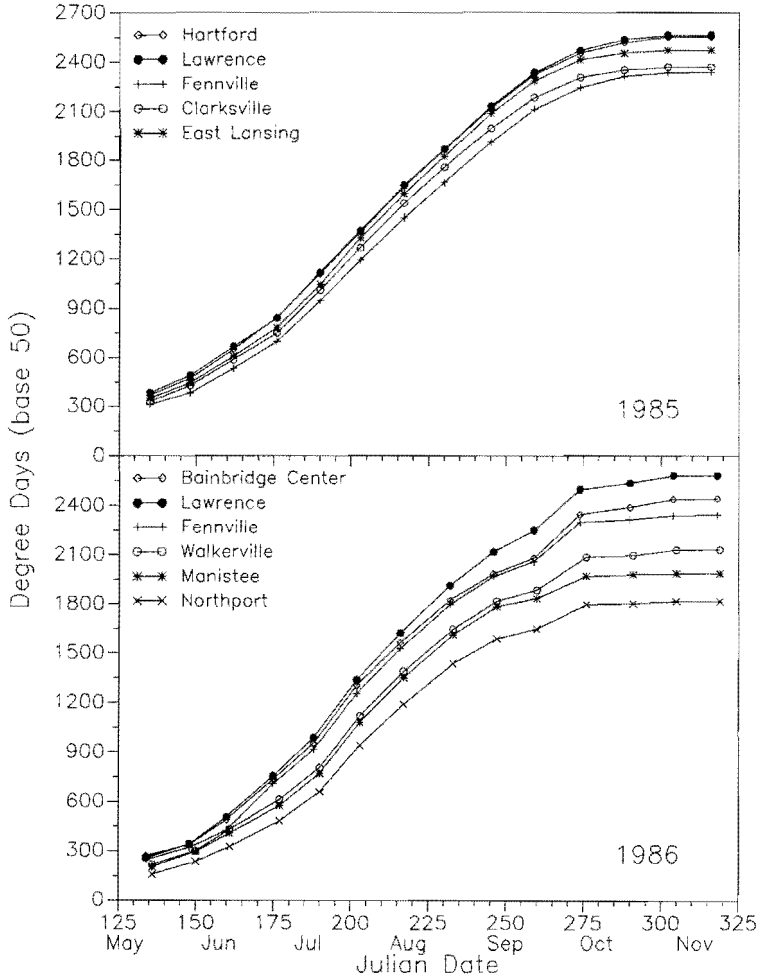

Fig. 1. Accumulation of degree day (base 50) heat units (Baskerville and Emin 1969) over time at the sites during both 1985 and 1986 field seasons.

had greater latitude differences from south to north and a corresponding decrease in degree day accumulation northward.

The two week lag in degree day accumulation probably explains the delay in chokecherry development and X-disease symptom expression. The presence of chokecherry along roadways indicates that many bushes are not being eradicated per MDA regulations and therefore may once again be serving as a major alternate host of X-disease pathogen.

Of all the known species of X-disease vector leafhoppers found present in 1985 and 1986, only four seem to be common enough to warrant our attention unless one of the rare species is found to have a very high MLO infection rate or its feeding behavior

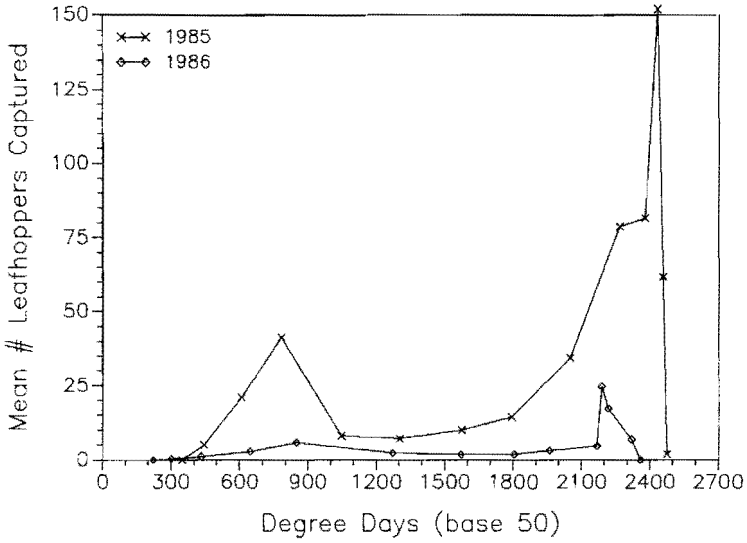

Fig. 2. Mean number of X-disease vector leafhoppers captured by yellow sticky board traps and in sweep nets, based on average degree day accumulations in 1985 and 1986 at all sites.

Table 2. Total number of X-disease vector leafhoppers captured by yellow sticky board traps and sweep nets, and percent relative abundance of each found in Michigan for both 1985 and 1986 field seasons.

	1985		1986	
Species	Total	% of total	Total	% of total
P. irroratus	1790	72.47	278	60.57
S. acutus	529	21.42	144	31.37
C. clitellarius	20	0.81	17	3.70
N. seminuda	92	3.72	5	1.09
Scaphoideus spp.	23	0.93	4	0.87
Fieberiella florii (Stal.)	2	0.08	3	0.65
Orientus ishidae (Mat.)	1	0.04	4	0.87
Gyponana lamina DeLong	13	0.53	4	0.87
Totals	2470		459	

predisposes it to transmit more frequently. *P. irroratus* is still the most common vector leafhopper in Michigan, representing 73% of the total number caught, with *S. acutus* second most common at 22%. This confirms the earlier work by Taboada et al. (1975) and Rosenberger (1977). The graphic evidence (Fig. 2) that X-disease vectors are bivoltine is largely influenced by the two generations of *P. irroratus*, which constitutes the largest portion of the vector population. Further work on the number of generations of other vector species found in Michigan would help to clarify this observation.

Distributions of leafhopper populations were influenced by sample location in the state. *P. irroratus* was commonly found in the southwest and central sites. Since the second

Table 3. Number of X-disease vector leafhoppers captured at each field site during 1985 and/or 1986.

Site	Species			
	P. irroratus	*S. acutus*	*C. clitellarius*	*N. seminuda*
Bainbridge Center[c]	40	21	0	2
Clarksville[b]	101	45	3	3
East Lansing[b]	641	19	4	45
Fennville[a]	217.5	94.5	3.5	13.5
Hartford[b]	276	145	5	3
Lawrence[a]	244	96	1.5	8.5
Manistee[c]	39	17	12	0
Northport[c]	2	23	0	0
Walkerville[c]	46	22	2	0
Totals	1606.5	482.5	32.0	75.0
Means	178.5	53.6	3.6	8.3
% of total	73.1	22.0	1.5	3.4

[a]average of 1985 and 1986 data.
[b]1985 data.
[c]1986 data.

generation of *P. irroratus* occurs at degree day accumulations greater than 2200 DD (Fig. 2), areas that do not reach this degree day accumulation probably do not have a second generation. This is most likely the reason why *P. irroratus* is rare in Leelanau County, where less than 1900 DD (base 50) were accumulated in 1986, and only in exceptional years are more than 2000 DD accumulated (MSU CCMS data).

C. clitellarius was found in significant numbers only at the Manistee site and thus may be an important vector in that area. Since the most common vector leafhopper found in Leelanau County was *S. acutus*, but at a low density when compared with other sites, the chance of X-disease transmission by leafhoppers there seems low.

Selection of sampling methods for use in future X-disease monitoring efforts should consider the effectiveness of the yellow sticky board traps, with over 90% of all vector leafhoppers captured by this method. Although sweep net sampling is the best method of detecting leafhoppers moving into and out of orchards in a short period of time (Mowry and Whalon 1984), sweep net sampling alone is of minor importance and an inefficient, labor-intensive, and incomplete sampling method for long-term X-disease vector monitoring.

Presence in the northwest area of chokecherry exhibiting X-disease symptoms indicate that a wild source of X-disease inoculum is present, and that transmission among chokecherry does occur. However, the limited distribution of populations of vector leafhoppers in this region may be preventing the vector transmission of X-disease to peach and cherry in the northwest part of Lower Michigan.

ACKNOWLEDGMENTS

We thank Jay Matthes and Martha Zemper for their assistance in the field, and Alan Jones, David Smitley and James Miller for reviewing early drafts of this manuscript. The yellow sticky board trap handling equipment used in this study was donated by Dr. Al Jones of the Department of Botany and Plant Pathology. This is Michigan State University Agricultural Experiment Station Journal Article No. 12379. This research was supported in part by USDA grant no. 85-CRSR-2-2551 to Michigan State University.

LITERATURE CITED

Baskerville, G. L. and P. Emin. 1969. Rapid estimation of heat accumulation from maximum and minimum temperatures. Ecology 50:514–517.

Fedewa, D. J. and S. J. Pscodna. 1982. Michigan orchard and vineyard survey 1982. Michigan Dept. Agric. 49 pp.

Gilmer, R. M. 1954. Insect transmission of X-disease virus in New York. Plant Dis. Rep. 38:628–629.

Gilmer, R. M., J. D. Moore, and G. W. Keitt. 1954. X-disease virus: I. Host range and pathogenesis in chokecherry. Phytopathology 44:180–185.

Gilmer, R. M., D. H. Palmiter, G. A. Schaefers, and F. L. McEwen. 1966. Leafhopper transmission of X-disease virus of stone fruits in New York. New York State Agric. Exp. Sta. (Geneva) Bull. 813. 22 pp.

Hildebrand, E. M. 1953. Yellow-red or X-disease of peach. Cornell Univ. Agric. Exp. Sta. Memoir No. 323. 54 pp.

Jensen, D. D. 1957. Transmission of peach yellow leaf roll virus by *Fieberiella florii* (Stal.) and a new vector, *Osbornellus borealis* DeL. & M. J. Econ. Entomol. 50:668–672.

McClure, M. S. 1980. Spatial and seasonal distributions of leafhopper vectors of peach X-disease in Connecticut. Environ. Entomol. 9:668–672.

Mowry, T. M. 1982. Leafhopper sampling in Michigan peach orchards and serological detection of a spiroplasma associated with X-disease in plant and insect tissue. M. S. Thesis. Michigan State University, East Lansing, MI. 134 pp.

Mowry, T. M. and M. E. Whalon. 1984. Comparison of leafhopper species complexes in the groundcover of sprayed and unsprayed peach orchards in Michigan. Great Lakes Entomol. 17:205–209.

Robinson, G. 1985. 1985 Peach virus annual report. Mich. Dept. Agric. Memorandum of October 4, 1985. 4 pp.

Rosenberger, D. A. 1977. Leafhopper vectors, epidemiology and control of peach X-disease. Ph.D. Dissertation. Michigan State University, East Lansing, MI. 95 pp.

Rosenberger, D. A. and A. L. Jones. 1978. Leafhopper vectors of the peach X-disease pathogen and its seasonal transmission from chokecherry. Phytopathology 68:782–790.

Taboada, O., D. A. Rosenberger, and A. L. Jones. 1975. Leafhopper fauna of X-diseased peach and cherry orchards in southwest Michigan. J. Econ. Entomol. 68:255–257.