Hawaii Agriculture Research Center

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Monitoring a Newly-Introduced Watercress Leafhopper in Central Oahu

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Summary

Yellow sticky cards were placed on the borders of five watercress (*Nasturtium microphyllum*) farms in the Aiea/Pearl City area and in mixed vegetable farms in Ewa and Kunia to monitor the potential spread of *Macrosteles* sp. nr. *severini*, a newly-introduced leafhopper (Homoptera: Cicadellidae) that became established on watercress in 2000. Trapping started in late March 2002, and continued through late July 2002. Traps were changed about every 10 days. Traps were also placed on a lettuce farm in Haleiwa and a tomato farm in Waialua and changed every two weeks. Low numbers of *M.* sp. nr. *severini* were trapped on three of five watercress farms sampled in April, and also in low numbers on one watercress farm in June and July. *Macrosteles* sp. nr. *severini* was never found on yellow sticky cards placed in Ewa, Kunia, Haleiwa, or Waialua.

Introduction

During the summer of 2000, watercress grown on farms in the Aiea, Pearl City, Waiawa, Waiau and Pearl Ridge areas of Oahu began exhibiting chlorosis, shoot proliferation (witches'-broom), distortion of leaves, and overall decline. Plants were analyzed for problems related to fertility, salinity, and other stresses. In October of 2001, pathologists at the University of Hawaii identified the Severe strain of Aster Yellows in symptomatic watercress. On October 30, 2001, extension agents from the College of Tropical Agriculture and Human Resources collected a previously unknown leafhopper from afflicted watercress farms. R. Gill of the California Department of Food and Agriculture identified the leafhopper as the aster leafhopper, *Macrosteles fascifrons* (Stål). This species is the most important vector of the Aster Yellows phytoplasma.

Aster Yellows belongs to the group of plant diseases called phytoplasmas. It has many strains which can cause serious economic losses across a wide range of agronomic, horticultural, and ornamental crops. Gill's identification of the aster leafhopper caused concern in Hawaii's

agricultural community, because this leafhopper can vector Aster Yellows to tomatoes, lettuce, papaya, and many other crops that are important to the state's diversified agriculture. The primary concern was that the leafhopper would spread Aster Yellows from watercress in the Pearl City area to mixed vegetable farms on the Ewa plain, Kunia, and to the windward side of the island.

The Hawaii State Department of Agriculture provided funding to establish a limited monitoring program using yellow sticky cards, which are attractive to leafhoppers and other insects, in order to determine if the newly-introduced leafhopper was dispersing beyond the Pearl City area and becoming established in agricultural areas in central Oahu. J. McHugh Jr. of Crop Care Hawaii LCC identified trapping sites on five watercress farms, as well as at Aloun Farms in Ewa, Larry Jefts' farm in Kunia, and Aloun Farms in Kunia. McHugh also established trapping stations at a hydroponic lettuce farm in Haleiwa, and a tomato farm in Waialua. H. Smith of the Hawaii Agriculture Research Center (HARC) established trapping sites at the HARC Kunia Substation.

W. Borth of the University of Hawaii identified the strain of Aster Yellows affecting watercress on Oahu as Severe Aster Yellows. This strain of Aster Yellows can infect hundreds of different crops and weeds in over 40 plant families (see Nielson 1968 for references). It can be vectored by several other species of leafhopper in addition to *M. fascifrons* (Appendix 1). The only other known leafhopper vector of Aster Yellows established in Hawaii is *Acinopterus angulatus* Lawson. Gill suggests that other unrecorded leafhopper species may also vector Aster Yellows.

In May 2002, an alternate identification of the leafhopper was provided by K.G.A. Hamilton of Agriculture and Agrifood Canada, who determined that the leafhopper affecting watercress on Oahu was an undescribed species, *Macrosteles* sp. nr. *severini* Hamilton. According to Hamilton's concept, this is a close relative of the aster leafhopper. Little is known about its biology or distribution. While the classification of the leafhopper vector remains in dispute, the identity of the pathogen - Severe Aster Yellows strain of Aster Yellows - is confirmed. The concern that this disease may spread to other crops remains valid, in part because the Severe Aster Yellows strain of Aster Yellows can be vectored by other leafhoppers.

Methods

Olson yellow sticky cards (3" x 5", Medina, OH) were placed around five watercress farms and within three mixed vegetable farms in central Oahu to check for the presence of the newly introduced leafhopper, *Macrosteles* sp. nr. *severini*. Cards were thumb-tacked to 12" wooden stakes (Dayton Garden Labels, Dayton, OH) which were placed in the ground with the card oriented toward the prevailing winds. Cards were situated 6-8" from the ground.

Two to five cards were positioned around the perimeter of the watercress farms, which ranged in size from 0.2-1.0 ha. On the vegetable farms, cards were placed in groups of three along the edge of cropped areas, with a distance of about 30 m between cards. Cards were changed on average every 10 days, but the trapping interval varied. The number of cards collected from each site and the number of days the cards were exposed are summarized in Table 2. Smith changed traps on watercress farms and all other leeward sites and recorded all trap data. McHugh changed the traps in Haleiwa and Waialua every two weeks.

Cards were first set out March 12-15, 2002. No traps were set out from March 15-25. Continuous trapping on watercress farms was carried out from March 26-July 22, after which all trapping was discontinued. Trapping on vegetable farms was initiated between March 26 and April 9 at different sites. One site (Aloun Farm, Kunia) was abandoned on April 29 because the traps were consistently destroyed by farm activity. From March 15 through July 22, traps at a hydroponic lettuce farm in Haleiwa and on a tomato farm in Waialua were set out and changed every two weeks.

Yellow sticky cards were placed in plastic bags for transport back to the laboratory, where they were examined using a dissecting microscope. Commonly found groups of leafhopper were sent to C. Dietrich of the Illinois Natural History Survey for identification. Numbers of commonly appearing genera were recorded from each trap, and totaled for each trapping period. The total number of individuals from a given genus were then grouped according to whether they were collected on watercress farms or vegetable farms. Data from traps in Haleiwa and Waialua were not included, because these traps rarely contained leafhoppers.

The number of days that traps were exposed varied, as did the number of traps set out and collected during each trapping period. New sites were added during the first weeks, and a few traps were accidentally destroyed by farm activity each week. Overall trap counts for different trapping periods could therefore not be compared on the same basis.

In order to be able to compare leafhopper counts from different trapping periods on a trap/day basis, a conversion factor was calculated by multiplying the number of days traps were exposed by the total number of traps set out in either watercress farms or vegetable farms for each period. In order to compare trap counts from different trap periods, totals can be divided first by the conversion factor (Table 1).

Table 1. Numbers of major leafhopper genera caught per trapping period.

Dates	Area	*Balclutha*	*Draeculacephala*	*Empoasca*	*Macrosteles*	*Xyphon*	Total	Conversion
3/12-3/15	**Watercress**	**13**	**2**	**24**	**0**	**23**	**62**	**48**
	Mixed Farms	-	-	-	-	-	-	-
3/26-4/1	**Watercress**	**5**	**0**	**176**	**3**	**94**	**278**	**48**
	Mixed Farms	10	0	143	0	27	180	126
4/1-4/9	**Watercress**	**10**	**3**	**113**	**8**	**70**	**204**	**112**
	Mixed Farms	16	0	245	0	60	321	216
4/9-4/17	**Watercress**	**3**	**6**	**95**	**2**	**108**	**214**	**128**
	Mixed Farms	23	0	141	0	34	198	248
4/17-4/22	**Watercress**	**7**	**2**	**71**	**0**	**22**	**102**	**70**
	Mixed Farms	28	0	80	0	5	113	140
4/22-4/29	**Watercress**	**7**	**1**	**90**	**0**	**17**	**115**	**112**
	Mixed Farms	45	0	97	0	1	143	189
4/29-5/6	**Watercress**	**1**	**4**	**63**	**0**	**0**	**68**	**91**
	Mixed Farms	13	0	12	0	6	31	126
5/6-5/15	**Watercress**	**2**	**4**	**99**	**0**	**28**	**133**	**144**
	Mixed Farms	9	0	67	0	9	85	234
5/15-5/24	**Watercress**	**1**	**0**	**29**	**0**	**14**	**44**	**117**
	Mixed Farms	0	0	6	0	3	9	180
5/24-6/3	**Watercress**	**4**	**0**	**14**	**1**	**6**	**25**	**150**
	Mixed Farms	5	0	24	0	3	32	250
6/3-6/14	**Watercress**	**1**	**3**	**54**	**5**	**6**	**69**	**176**
	Mixed Farms	1	0	3	0	3	7	275
6/14-6/24	**Watercress**	**33**	**1**	**63**	**0**	**0**	**97**	**140**
	Mixed Farms	0	0	17	0	0	17	220
6/24-7/9	**Watercress**	**6**	**0**	**97**	**0**	**1**	**104**	**196**
	Mixed Farms	0	0	6	0	0	6	252
7/9-7/16	**Watercress**	**0**	**0**	**38**	**3**	**1**	**42**	**98**
	Mixed Farms	0	0	8	0	0	8	161
7/16-7/22	**Watercress**	**1**	**1**	**68**	**0**	**2**	**72**	**84**
	Mixed Farms	0	0	5	0	0	5	150
	Group Totals	**244**	**27**	**1948**	**22**	**543**	**2784**	

Table 2. Number of traps per farm and exposure periods

Farm	Crop	No. traps	Trap periods
Oshita	Watercress	2	March 12-15; March 26-July 22
Nakatani	Watercress	4	March 12-15; March 26-July 22
Watabu	Watercress	2	March 12-15; March 26-July 22
Kobashigawa	Watercress	3	March 12-15; March 26-July 22
Sumida	Watercress	5	March 12-15; March 26-July 22
Aloun Farms, Ewa	Bean	3	March 26-July 22
	Corn	3	March 26-July 22
	Eggplant	3	April 1- July 22
	Squash	3	April 1- July 22
HARC Kunia Substation	Papaya	3	March 12-15; March 26-July 22
	Corn	3	March 12-15; March 26-July 22
Aloun Farms, Kunia	Lettuce	3	March 26-April 29
Jefts Farm, Kunia	Tomato	3	March 26-July 22
	Pepper	3	March 26-July 22
	Melon	3	April 9-July 22
	Cabbage	3	April 9-July 22

Results

Yellow sticky traps placed around watercress farms in the Pearl City area and in mixed vegetable farms in Ewa, Kunia, Haleiwa, and Waialua from March 26 through July 2, provided no evidence that the newly-introduced leafhopper, *Macrosteles* sp. nr. *severini*, was spreading from watercress to other farms. Low numbers of *M*. sp. nr. *severini* were trapped at watercress farms early in April, and on one farm in early June and mid-July (Table 1). *Macrosteles* sp. nr. *severini* was never found on traps placed on mixed vegetable farms in Ewa, Kunia, Haleiwa, and Waialua. The most commonly trapped genus of leafhopper was *Empoasca*, followed by *Balclutha*, and *Xyphon* (formerly *Carneocephala*) (Table 1). Of these, *Empoasca* is the only economically damaging group. *Empoasca* spp., particularly *E. solana* DeLong and *E. stevensi* Young, can reach high populations on bean, papaya, and other crops important in Hawaii, where they cause characteristic hopper burn. They are not known to vector pathogens. *Draeculacephala* spp. were also trapped in low numbers.

Conclusions

Farm managers at each watercress farm included in this study began periodic applications of malathion to control *Macrosteles* sp. nr. *severini* before trapping was initiated. These spray

applications continued at varying frequencies during the course of the survey, and appear to have reduced the incidence of the leafhoppers and Aster Yellows to manageable levels.

The identity of the newly-introduced leafhopper remains in dispute among leafhopper specialists. R. Gill believes that there are many different strains or biotypes of *M. fascifrons* that may behave differently, that is, prefer distinct habitats and crops. K. G. A. Hamilton believes the *Macrosteles* complex is comprised of different species rather than different strains of the same species. Members of the task force working on the watercress yellows problem on Oahu decided in August 2002 to adopt Hamilton's designation. There is no officially accepted common name for *M.* sp. nr. *severini*.

Being an undescribed species, very little is known about the biology, host range, or distribution of *M.* sp. nr. *severini*. The only available information is that it has been previously collected in Victorville, California, which has semi-desert conditions. Two years since arriving on Oahu, the leafhopper has been found only on watercress and adjacent weeds in the Pearl City area. The fact that *M.* sp. nr. *severini* has not yet been trapped outside watercress farms does not mean that the insect is incapable of moving into other areas. The urban industrial belt that separates the Pearl City watercress farm area from agriculture on leeward Oahu may have discouraged movement. The comparatively arid farming environment of Ewa and Kunia may not be conducive to the build-up of this pest. Most importantly, crops on these farms are usually sprayed with broad spectrum pesticides to manage other pests, and leafhoppers are easily killed by pesticides. One reason the leafhopper was able to build up on watercress is that the crop is rarely sprayed.

These factors and as yet unknown aspects of the leafhopper's biology may explain why *M.* sp. nr. *severini* has not become established outside watercress farms on Oahu. However, it is still possible that *M.* sp. nr. *severini* could be transported beyond the Pearl City area and become established on weeds or crop plants in other parts of Oahu and the neighbor islands. Several weed species on Oahu have been identified as hosts for Aster Yellows, and these can serve as reservoirs for the phytoplasma (Appendix 2). Growers and crop protection specialists must continue to be aware of the potential threat from Aster Yellows to crops other than watercress. Information should be distributed to growers to help them identify the various symptoms of Aster Yellows as they appear on different crops.

Acknowledgment

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References

Nielson, M.W. 1968. The leafhopper vectors of phytopathogenic viruses (Homoptera: Cicadellidae). Taxonomy, biology and virus transmission. United States Department of Agriculture, Agricultural Research Service. Technical Bulletin No. 13882. Washington, DC.

Appendix 1. Known vectors of Aster Yellows worldwide (Nielson 1968) *

North American Aster Yellows (western strain)
- *Gyponana hasta* DeLong
- *Scaphytopius acutus* (Say)
- *Scaphytopius delongi* Young
- *Scaphytopius irroratus* (Van Duzee)
- *Acinopterus angulatus* Lawson
- *Macrosteles fascifrons* (Stål) complex
- *Endria inimica* (Say)
- *Chlorotettix similis* DeLong
- *Colladonus flavocapitatis* (Van Duzee)
- *Colladonus geminatus* (Van Duzee)
- *Colladonus holmesi* Bliven
- *Colladonus intricatus* (Ball)
- *Colladonus kirkaldyi* (Ball)
- *Colladonus montanus montanus* (Van Duzee)
- *Colladonus rupinatus* (Ball)
- *Euscelidius variegatus* (Kirschbaum)
- *Excultanus incurvatus* (Osborn & Lathrop)
- *Fieberiella florii* (Stål)
- *Idiodonus* sp.
- *Paraphlepsius apertinus* (Osborn & Lathrop)
- *Texananus lathropi* (Baker)
- *Texananus latippex* DeLong
- *Texananus oregonus* (Ball)
- *Texananus pergradus* DeLong
- *Texananus spatulatus* (Van Duzee)

North American Aster Yellows strain (eastern strain)
- *Macrosteles fascifrons* (Stål) complex

European Aster Yellows
- *Aphrodes bicincta* (Schrank)
- *Macrosteles laevis* (Ribaut)
- *Macrosteles quadripunctulatus* (Kirschbaum)
- *Macrosteles sexnotatus* (Fallen)

Japanese Aster Yellows
- *Scleroracus flavopictus* (Ishihara)

*****This is the most complete list of vectors of Aster Yellows. Additional strains of Aster Yellows have been identified since Nielson compiled this list.

Appendix 2. Weed hosts of Aster Yellows on Oahu

Amaranth, *Amaranthus* spp. (Amaranthaceae)

False daisy, *Eclipta prostrata* (Asteraceae)

Flora's paint brush, *Emilia sonchifolia* (Asteraceae)

Sow thistle, *Sonchus oleraceus* (Asteraceae)

Plantain, *Plantago major* (Plantaginaceae)

Parrot's feather, *Myriophyllum brasiliense* (Haloragaceae)