WERA1007 - Curly Top virus Biology, Transmission, Ecology, and Management

Report Date 10/15/2012

Participants:

Creamer, Rebecca (creamer@nmsu.edu) - New Mexico State University, Entomology, Plant Pathology and Weed Science
Bob Hammon (bob.hammon@mesacounty.us) – Mesa County Extension, Colorado State University
Erik Wenninger (erikw@uidaho.edu) - University of Idaho, Twin Falls
Carl Strausbaugh (carl.strausbaugh@ars.usda.gov) - USDA-ARS, Kimberly, ID
Phil Miklas (phil.miklas@ars.usda.gov) - USDA-ARS, Pullman, WA
Rod Clark (Rodney.clark@cdfa.ca.gov) - Beet curly top virus control program, Fresno, CA
Bill Wintermantel (Bill.wintermantel@ars.usda.gov) - USDA-ARS, Salinas, CA

Annual Summary:

No annual meeting was held this year due to time and funding constraints by numerous individuals. Reports on curly top in western states were solicited from previous participants. Those that were sent in are presented below.

Rod Clark, CDFA, sent an extensive report (see full report below) on the curly top virus control program in California. A dry summer and fall produced few beet leafhoppers in the Central and Imperial Valleys. The extreme drought did not support sustained growth of weed hosts of the leafhoppers. Minimal sprays were made to roadside weed hosts. Disease symptoms of curly top were not seen in commercial fields of tomatoes or peppers.

Bill Wintermantel finished up work on Beet severe curly top virus and Beet mild curly top virus. The research project focused on the importance of specific hosts as virus reservoirs that contribute to movement of virus into host crops. He made a video on curly top viruses on tomato, which is available through Plant Management Network at www.plantmanagementnetwork.org/edcenter/seminars/tomato/curlytop/

Phil Miklas does not have any active research projects on curly top virus. For Washington in 2012, curly top incidence in beans has been very low. He is interested in the aspect of major genes and minor genes with broad spectrum resistance against different Geminivirus species such as Bct gene effective against both curly top and bean dwarf pub in Plant Dis 93:645-648. Bct being a dominant gene with linked markers is an attractive set up for candidate gene discovery given the new genomic tools available in bean for which the whole genome sequence was recently released, and large SNP panels will soon be available.

Bob Hammon, Colorado Extension, tested the impact of foliar/soil applications with Scorpion – dinotefuran on tomato.

Erik Wenninger reported a little bit of natural curly top pressure this year on the Kimberly, ID research farm. Only BSCTV and BCTV were found, but not BMCTV, in those plants. He sent a report (see below) of results from a beet leafhopper / curly top insecticide trial carried out by **Carl Strausbaugh**, Imad Eujayl, and himself last year. This work was part of a publication in Plant Disease that is listed below. They are conducting a similar trial this year that includes more foliar sprays with and without seed treatment; some of the foliars look very promising, but will wait to report on those results. They are also working on developing separate beet leafhopper colonies that have a single virus species or are virus-free in order to examine beet response to individual virus species.

Rebecca Creamer reported a medium low curly top year for southern New Mexico. She has three active curly top projects, one looking at competitive inhibition between curtoviruses, a second studying the role of endosymbionts in leafhopper transmission of curtoviruses, and the third dealing with methods for monitoring leafhopper movement and identification of key weed hosts.

Accomplishments

Collaborative curly top projects for 2012 were carried out between Rebecca Creamer and Robert Gilbertson, and between CDFA (Rod Clark) and Bill Wintermantel.

Impact Statement

The group has made an impact of curly top in the western U.S. The use of management strategies was assessed, the curly top viruses for particular areas was characterized, and the relationship between viruses and specific hosts.

Publications

The group did not publish report together, however, individual members published the results of their curly top work. A list of those publications are below.

Strausbaugh, C.A. and Wenninger, E.J. and Eujayl, Imad A. 2012. *Management of Severe Curly Top in Sugar Beet with Insecticides.* Plant Disease 96:1159-1164.

Sedano, M., Lam, N., Escobar, I., Cross, T., Hanson, S. F., and Creamer, R. 2012. Application of vascular puncture for evaluation of curtovirus resistance in chile pepper and tomato. Journal of Phytopathology 160:120-128.

Wintermantel, W.M. 2012. Curly Top Disease of Tomato. Plant Management Network. Available: http://www.plantmanagementnetwork.org/edcenter/seminars/Tomato/curlytop.

2012 California Update Curly Top Virus Control Program

(Communicated by Rod Clark)

Winter Survey

The San Joaquin Valley experienced above normal precipitation in October, 2011 from one large system. The precipitation was sufficient to allow for the sparse germination of winter annuals and grasses on the westside of the San Joaquin Valley. In Kern County, the germination was limited to the bottoms of ravines and low spots. In Kings and Fresno Counties, conditions were similar. Initial germination was found near the edges of paved roads and then developed in scattered locations depending on soil types.

No rain fell during the month of December and most of January which stressed and slowed the development of the sparse rangeland vegetation. The light green texture that began to appear in westside rangeland was observed reverting back to brown as the newly germinated grasses and winter annuals began dying back.

A significant storm came through the valley during the first of February which produced widespread precipitation to the westside of Kings, Kern and Fresno Counties. The moisture revived stressed plants and stimulated further germination. During the remainder of February, there was very little additional precipitation. By the end of February, rangeland vegetation had begun to stress and dye out just as it had done at the end of January. BLH counts remain low throughout the westside as sparse host plant conditions limited BLH development. Viable rangeland vegetation was restricted to the bottoms of draws and ravines.

Because BLH host plants were sparse and minimal in development due to the lack of rain, winter treatments on the west side of Fresno County were not performed

Spring Survey

Several small storm fronts came through in early March resulting in little precipitation for most westside locations. Several storms in late March produced more precipitation in Kern County than areas further to the north. 3rd instar nymphs were found on the Coalinga Nose on March 5th on short stressed, sparse filaree at 2-3 per 10 sweeps-no adults. This is about 2-3 weeks earlier than most years. Annual rangeland vegetation in most areas has dried and appears like summer, except for Warthan Canyon and the Big C. By the first week of March, nymphs were found in Warthan and the Big C, but only low counts could be obtained from the sparse, short and stressing vegetation.

A significant storm system came through the valley in the middle of March dropping 1-2 inches of rain and a significant snow fall in the Sierra. The westside received sufficient rains to soak the ground and stimulate the new germination of host plants. The rains fell mostly in the Coalinga area leaving the Kettleman Hills to the south and the Tumey Hills, to the north, with less precipitation. Surveys in the Coalinga Nose found 2-3

spring adult averages on filaree. Peppergrass and *Plantago* remain absent from the rangeland vegetation but small Russian thistle plants were observed in some locations.

Two more storms came through the San Joaquin Valley from April 11-14. Germination was stimulated in some areas and the vegetation in Warthan and the Big "C" was given extended life. The April rains stimulated Russian thistle emergence in locations and concentrations not observed in normal years. First generation adult BLH migration was observed on some roadsides and in newly emerged Russian thistle.

By late April rangeland vegetation was drying. The low BLH population remained scattered on stressing, sparse filaree and newly emerged Russian thistle. Peppergrass and *Plantago* development was almost absent during the winter and spring which are the two most significant reproductive host plants. Filaree was the only host plant available to the BLH in 2012 and it came up late and was sparse. The spring BLH populations did not increase substantially over population levels found overwintering in December and January.

Due to the successive dry periods and dye back of host plants through the winter and spring, BLH populations did not develop and rise to significant numbers. No aerial treatments performed in the San Joaquin Valley during the spring of 2012. The absence of treatments during spring has made the spring of 2012 one of the strangest years on record. During my tenure on the Program, there has never been a spring with constantly poor host plant conditions throughout the entire westside of the San Joaquin Valley.

BCTV Infection in Susceptible Crops

Following the limited spring migration from rangeland habitat in April, low BLH populations were found on various host plants including London rocket, mustards, goosefoot and young Russian thistle developing along roadsides. Limited ground-rig spot treatments were conducted adjacent to susceptible crops in Kern, Kings and Fresno Counties. Surveys of susceptible crops through the spring and early summer found a low incident of Beet Curly Top Virus (BCTV) symptoms in tomatoes and peppers. Very few plants exhibiting BCTV symptoms were found in tomato fields generally. The incidence of BCTV during the spring of 2012 was substantially less than 1 percent.

Imperial and Palo Verde Valley Survey

No host plants could be found at Travertine Point, or anywhere near the Salton Sea. The entire region was parched and bare. Lack of precipitation caused the creosote and other desert plants to completely shut down. Roadsides were also devoid of vegetation, except for dried remnants inside the road shoulder, and a few thin strips of *Chenopodium* along the very edge of Hwy 86. The whole north-west region appeared desolate and bleak.

A check of the West Mesa found conditions similar. Scant patches of dried *Plantago* and *Verbena* appeared to be all that remained of host plants. Soil conditions in this region are barren and dry. Host vegetation was visibly absent along roadsides reducing available BLH habitat. Some places were recently graded and others appeared to have been treated by growers.

North and east of El Centro, surveys produced a few significant BLH counts on scarce patches of roadside *Chenopodium*. BLH counts varied from 5–15 per 10 sweeps with equal numbers of adults and nymphs. Numbers of *Agallia* leafhoppers were a little higher. Because host plants are so limited and scarce, BLH activity was ostensibly concentrated in these small areas. Most of the roadsides appear relatively clean of vegetation, leaving very little for consideration or concern.

Roadside *Chenopodium*, in the Palo Verde area, produced 10–20 BLH adults, plus several large nymphs, per 10 sweeps. Surveys conducted on Highway 78 were infrequent and far between. Most of the area harbors no host plants, or has been entirely cleared of vegetation. Severe drought-like conditions, coupled with on-going road maintenance, has reduced host plant incursions on many roadsides south and east of Blythe. As a result, BLH surveys were very limited in scope. Counts continued to range from 10–20 adults, plus a few nymphs when host plants could be located. North of Blythe, desert conditions remain extremely dry. On the bluffs, near the golf course, trace remnants of desiccated *Plantago* are all that remains. There was no BLH activity anywhere. Roadsides had minimal vegetation, and surrounding desert shrubs appeared stressed and dehydrated.

Due to the lack of host plants and low BLH population, ground-rig spot treatments were not performed in the Imperial or Palo Verde Valleys in 2012.

Salinas Valley Survey

Host plant and crop survey was performed in the Salinas Valley June 11-14, 2012. Survey efforts were assisted by the Agricultural Commissioners office in King City who provided Program staff with a new ranch map and locations of susceptible host crops.

Roadside host plants this year consisted mostly of mustards and small amounts of Russian thistle. BLH counts on roadside host plants were very low averaging 1 per 20 sweeps on Russian thistle and slightly smaller counts on mustards. Road crews were observed mowing roadside vegetation on some of the county roads in the area.

There were more pepper fields than tomato plantings. Both tomato and pepper fields looked in good growing condition with no symptoms of BCTV.

BEET (*Beta vulgaris*)
Curly top; *Beet severe curly top virus*

C. A. Strausbaugh and I. A. Eujayl, USDA-ARS NWISRL, 3793 N. 3600 E., Kimberly, ID 83341; Erik Wenninger, Univ. of Idaho, Twin Falls R&E Center, Twin Falls, ID 83303

Sugar beet pest control with insecticide seed and foliar treatments in Twin Falls County, ID, 2011.

Conventional commercial sugar beet cultivars (Beta4430R and Crystal217R) and insecticide seed and foliar treatments were evaluated on the USDA North Farm in Kimberly, ID where beet curly top and insects had been a problem in previous years. The field had been in barley the previous year and was disked and plowed in fall 2010. Fertilizer (80 lb N/A + 120 lb P_2O_5/A) and ethotron (2 pints/A) was applied and incorporated with a roller harrow on 20 Apr. The field trial was planted on 3 May. The plots were planted to a density of 142,560 seeds/A, and thinned to 47,520 plants/A on 14 Jun. Plots were four rows wide (22 in-row spacing) and 34 ft long. The experimental design was a randomized complete block design with eight replications. The crop was managed according to standard cultural practices. Prior to thinning, a stand count was taken on 25 May when the plants had only cotyledons and no true leaves. Percentage of plants with leafminer in the center two rows was recorded on 20 Jun at the eight leaf growth stage. On 27 Jun, six viruliferous beet leafhoppers per plant were released to generate uniform curly top pressure. Curly top in the center two rows was rated on a scale of 0 to 9 (0 = healthy, 9 = dead) on 19 Jul, 16 Aug, and 19 Sep. The center two rows were harvested on 4 Oct using a small plot harvester. The sugar content of the beets was determined by the Amalgamated Sugar Co. laboratory, and recoverable sugar was estimated. Data were analyzed using the Proc GLIMMIX procedure in SAS and mean comparisons were conducted using the least squared means (LSMEANS) statement (alpha = 0.05).

Leafminer and curly top pressure were uniform throughout the field. The spring weather was unusually cool and wet while the fall weather was warm and dry. With Beta4430R, there were no differences for stand. With Crystal217R, significant differences for stand were present, since some treatments had more stand than the non-treated check. Thus, there was no evidence for phytotoxicity, but the leaves on the plants with NipsIt fungicide package had an unusual lollipop shape at the four leaf growth stage. These plants grew out of the leaf deformation and responded normally the rest of the season. On 20 Jun (48 days after planting) at the 8-leaf growth stage, leafminer control with the seed treatments was nearly complete since infestations ranged from 0 to 1%. Reduction in curly top rating with all seed treatments (hoppers were released 55 days after planting) was significant when compared with the non-treated check. The Scorpion foliar treatment provided similar curly top control as some or all of the seed treatments depending on rating date and cultivar. The Movento + Provado foliar treatment was not different from the non-treated check for curly top control. Sugar content did not vary among treatments with Beta4430R, but differences were evident with Crystal217R. All seed treatments and the Scorpion foliar treatment all improved root yield and ERS (estimated recoverable sugar) compared to the non-treated check and the Movento + Provado foliar treatment.

Insecticide seed treatment[z]	Fungicide seed treatment	Foliar insecticide treatment	Stand (%)[y]	Leafminer (%)[x]	Curly top[w]			Root yield (t/A)	Sugar content (%)	Estimated recoverable sugar (lb/A)
					19 Jul	16 Aug	19 Sep			
Beta 4430R										
None	AT	None	53	97 a	3.8 a	6.5 a	8.1 a	8.69 c	15.14	2,285.36 c
None	AT	MP 2x	50	95 a	3.2 a	6.4 a	8.2 a	10.06 c	15.00	2,271.61 c
None	AT	Scorpion	54	91 b	2.6 b	4.1 bc	5.1 bc	26.96 ab	15.07	6,770.14 ab
Poncho Beta	AT	None	54	0 c	2.3 b	3.8 bc	4.7 c	26.66 ab	15.59	7,030.21 ab
Poncho Beta	AT	MP 2x	55	1 c	2.4 b	4.2 b	5.9 b	25.31 b	15.10	6,366.88 b
NipsIt	M8	None	54	0 c	2.3 b	4.0 bc	5.0 bc	27.65 ab	15.18	6,991.90 ab
NipsIt	M16	None	58	0 c	2.4 b	3.7 bc	4.6 c	30.04 ab	15.57	7,810.10 a
NipsIt	M23	None	53	0 c	2.6 b	3.6 bc	4.6 c	28.64 ab	15.54	7,331.65 ab
Cruiser Force	AM	None	54	1 c	2.2 b	3.4 c	4.4 c	31.15 a	15.44	8,100.45 a
P > *F*[v]			0.4151	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0878	<0.0001
Crystal 217R										
None	AT	None	70 c	84 a	3.8 a	6.0 a	7.3 a	13.04 d	14.03 e	3,116.33 e
None	AT	MP 2x	78 a	80 a	3.3 ab	5.8 a	6.8 a	14.63 d	14.54 d	3,566.38 e
None	AT	Scorpion	75 a-c	72 b	3.0 bc	4.0 b	4.5 b	25.88 c	14.76 cd	6,331.05 d

Poncho Beta	AT	None	81 a	0 c	2.8 cd	3.6 b-d	4.3 b-d	28.19 c	14.94 bc	6,963.94 cd
Poncho Beta	AT	MP 2x	77 ab	1 c	2.8 cd	4.0 b	4.6 b	28.33 bc	15.21 a	7,165.22 cd
NipsIt	M8	None	70 bc	0 c	2.2 ef	3.2 cd	3.7 d	33.14 a	15.34 a	8,398.01 a
NipsIt	M16	None	82 a	0 c	2.4 d-f	3.1 d	3.7 d	34.45 a	15.44 a	8,876.52 a
NipsIt	M23	None	69 c	0 c	2.1 f	3.2 cd	3.8 cd	31.69 ab	15.41 a	8,186.00 ab
Cruiser Force	AM	None	80 a	0 c	2.6 c-e	3.7 bc	4.4 bc	29.23 bc	15.21 ab	7,446.15 bc
P > F			0.0009	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

[z] The insecticide seed treatments were None = no insecticide treatment; Poncho Beta = 60 g ai clothianidin/100,000 seed + 8 g ai beta-cyfluthrin/100,000 seed; NipsIt = 60 g ai clothianidin/100,000 seed; Cruiser Force = 60 g ai thiamethoxam/100,000 seed + 8 g ai tefluthrin/100,000 seed. The fungicide seed treatments included AT = Allegence FL (15.6 g ai metalaxyl /100 kg) and Thiram 42S (250 g ai thiram/100 kg); M8, M16, and M23 = Metlock 3.7 FS (0.008, 0.016, and 0.023 fl oz/cwt, respectively) + V-10170 2.65 FS (0.75 fl oz/cwt); and AM = Apron XL (7.5 g ai mefenoxam/100 kg) and Maxim 4FS (2.5 g ai fludioxonil/100 kg). The foliar insecticide treatments were applied twice (6 days prior to hopper release on 21 Jun and repeated on 5 Jul which was 8 days after hopper release): MP = Movento 240 SC + Provado 1.6 was applied at 5.0 and 3.8 fl oz/A, respectively and S = Scorpion 35SL was applied at 5.25 fl oz/A. All foliar sprays also included MSO (methylated seed oil plus non-ionic surfactant) at 0.5% v/v and were buffered to pH 6.0.

[y] The number of plants at the cotyledon growth stage (prior to thinning) were counted in 10 ft of row and percent emergence determined.

[x] Percentage of plants infested with Spinach leafminer. Data analysis was conducted with arcsine transformed data but the untransformed means are presented.

[w] Curly top in the center two rows was rated on a scale of 0 to 9 (0 = healthy, 9 = dead) in a non-categorical manner.

[v] *P > F* was the probability associated with the F value. For each cultivar, means within a column followed by the same letter did not differ significantly based on least square means (LSMEANS) statement (alpha = 0.05).