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

Annual Meeting Dates: 07/24 - 7/25/2016

Annual Report Date 07/25/2016

**Participants:**

Rebecca Creamer ([creamer@nmsu.edu](mailto:creamer@nmsu.edu)) - New Mexico State University, Entomology,

Plant Pathology and Weed Science

Al Poplawsky ([alpop@uidaho.edu](mailto:alpop@uidaho.edu)) - University of Idaho, Dept of Plant Pathology

Jennifer Willems ([Jennifer.willems@cdfa.ca.gov](mailto:Jennifer.willems@cdfa.ca.gov)) - California Dept of Food and Ag/BCTV

Control Program

Lauren Murphy ([lauren.murphy@cdfa.ca.gov](mailto:lauren.murphy@cdfa.ca.gov)) - California Dept of Food and Ag/BCTV Control

Program

Tesneem Nusayr ([tessamn@nmsu.edu](mailto:tessamn@nmsu.edu)) - New Mexico State University, Molecular Biology

Carl Strausbaugh ([carl.strausbaugh@ars.usda.gov](mailto:carl.strausbaugh@ars.usda.gov)) - USDA-ARS, Kimberly, ID

Quaid Dobey ([quad09@nmsu.edu](mailto:quad09@nmsu.edu)) - New Mexico State University, Entomology, Plant

Pathology, and Weed Science

Phillip Miklas – ([phil.miklas@ars.usda.gov](mailto:phil.miklas@ars.usda.gov)) - USDA-ARS, Prosser, WA

Alvaro Soler – (alvaro.solergarzon@wsu.edu) - Washington State University, Prosser, WA

Marjo Ala-Poikela (marjoa@uidaho.edu) - University of Idaho, Dept of Plant Pathology

Thomas Koeps (Thomas.koeps@kws.com) - Betaseed Inc, Kimberly, ID

Kylie Swisher – ([kylie.swisher@ars.usda.gov](mailto:kylie.swisher@ars.usda.gov)) - USDA-ARS, Prosser, WA

Becky Cochran ([becky.cochran@ars.usda.gov](mailto:becky.cochran@ars.usda.gov)) - USDA-ARS, Prosser, WA

Randy Collins ([randy.collins@cdfa.ca.gov](mailto:randy.collins@cdfa.ca.gov)) - CDFA/BCTV Control Program

Silvia Rondon ([silvia.rondon@aregonstate.edu](mailto:silvia.rondon@aregonstate.edu)) - Oregon State University

Jim Crosslin ([voncross263@gmail.com](mailto:voncross263@gmail.com)) - retired USDA

Gaylord Mink ([gmink@charter.net](mailto:gmink@charter.net)) - retired Washington State University

Naidu Rayapati ([naidu@wsu.edu](mailto:naidu@wsu.edu)) - Washington State University, Prosser, WA

**Summary of Meeting Minutes**:

Phillip Miklas welcomed the group to the USDA/WSU Prosser Station. Rebecca Creamer explained a bit about the group and its purpose. Introductions were made, and the agenda was discussed. Steve Loring, administrator for the WERA1007 group explained a bit more about the program and specifically requested that all participants make sure to talk about the impact of their work.

Carl Strausbaugh presented background information on curly top and the beet leafhopper with emphasis on the disease in Idaho on sugarbeets. He also presented information on the symptoms and factors that influence the symptoms. In Idaho there are three generations of leafhoppers; the 1st in the desert with migration out mid May – June 1. He reported on his recent publication on the sequencing of curly top isolates collected through 2006-2007 and 2012-2015 surveys of infection of curly top in sugarbeets. Overall he found 11 BCTV strains based on whole genome sequencing: SvrPep (NM), Kim1, LH71, Mild, Wor, CO, Cal/Logan, Svr(CFH), PeCT, SpCT, and PeYD. The Mild, Worland, and CO strains formed a group, while the LH71, and Kim1 grouped together in a different clade. He found that the two Kim1 isolates are recombinants between Wor and Svr parents with the most variability in the V3, C2 and C3, and beginning of C1 regions. Idaho currently has primarily CO, Wor, and Cal/Logan strains, compared to the formerly large amounts of Svr that are now very reduced.

Carl also discussed the use of neonicitinoid seed treatment of Poncho for sugarbeets. He finds good coverage for 77 days, then suggests a foliar pyrethroid treatment of Mustang or Asana. The seed treatment of Poncho , Cruise or Nipsit are very effective leading to large increases in yield of 17-20% because the insecticides also control leafminers and aphids.

Marjo Ala-Poikela from Alex Karasev’s laboratory presented her characterization of a BCTV isolate from Chihuahua, Mexico. ELISA positive samples were subjected to PCR and sequencing. She found a putative recombinant with mild strain as a major parent, and severe strain as a minor parent. The region of the genome highly similar to the severe strain included C1 and C4. A 1.53-mer infectious clone was produced and used for agroinoculations. Compared to the control infections, it was less virulent than both mild and severe strain on sugarbeet, showed similar virulence as mild strain on tomato, but didn’t infect beans.

Gaylord Mink commented that poor symptoms of curly top in glass greenhouses had been detected at WSU in the past. They found that the plants appeared to need UV to get symptoms since, if tomato plants were grown under Lucite plastic (the type that yellows), they got symptoms, while they did not if grown under glass.

Alan Poplawsky from Alex Karasev’s laboratory reported on the host range of curly top infectious clones.  He found the CFH and Logan clones gave severe symptoms on susceptible sugarbeets, while the ID-Wor and Mex clones gave minimal symptoms on sugarbeets.  When they tested the same clones on the universal susceptible sugarbeet Monohikari, he found that the Logan clone killed the sugarbeets, the CFH clone began to kill the Monohikari, but plants had recovered by 10 weeks.  In comparison the ID-Worland clone gave slow low level of infection, but was dead by 10 weeks, and the Mexican clone gave slow low infection, but never killed the plants. A resistant sugarbeet, Kdh-13 either showed initial resistance to infection, a decreased rate of infection, or recovery after 10 weeks depending on the clone used for infection.  There are thus likely three types of resistance found in sugarbeets, 1) resistance to initial infection, 2) limitation of the rate of infection to a very slow progression, and 3) initial severe disease but then a near complete recovery.  He also reported on the symptoms of the clones in tomatoes, which were stunting, leaf curling, and discoloration which included chlorosis and vein purpling on the back of leaves.  He reported that the Logan clone killed all tomato varieties, CFH infection was low (27%) and progressed slowly, and Mex and ID-Wor gave intermediate levels of infections (38%) and progressed fairly slow.

Alvaro Soler from Phillip Miklas’ laboratory talked about his work on searching for the curly top resistance gene in beans. He reported that Andean bean germplasm have fewer genes than Central American gemplasm because of repetitive DNA and stress response, although both have 11 chromosome pairs. In the Andean lines, the Bct gene for resistance is found on chromosome 7, while another marker for resistance can be found on chromosome 6. He screened bean germplam using agroinoculation of bean through needle inoculation and found that the Bct resistant phenotype was in 60% of 367 snap bean lines. He also looked for better Bct resistance markers on genome 7, by looking for other genes around the scar marker. He found an exonuclease that explains 99% of phenotypic variation, so is likely a good marker. Bct resistance explains 30% of variation in bean golden mosaic and 77% of variation for reaction to bean dwarf mosaic virus.

Naidu Rayapati talked about grapevine leafroll disease in Washington. Grapes are grown primarily in central and eastern Washington on self-rooted grapevines (no phylloxera present). There are both wine and juice grapes grown, however, the acreage and production of the wine grapes has greatly expanded to 270,000 tons of wine grapes harvested from 60,000 acres, worth $4.8 million. Approximately 60% are red grapes (merlot, cabernet) and 40% are white grapes (Riesling, chardonnay). Symptoms of grapevine leafroll virus are only present in the wine grapes and only obvious in red grapes, but the others are infected. Symptoms only appear after grape ripening, when the red color is forming. A decrease in photosynthesis is found in red grapes that is associated with symptom production. GLRaV is semipersistently transmitted by mealybugs and soft scale insects. Most GLRaV are ampeloviruses, but GLRaV-2 is a closterovirus, and GLRaV-7 is a velarivirus. Washinton grapes are mostly infected with GLRaV-3 (86.8%), but there are small levels, 5%, of GLRaV-2 and GLRaV-4. His lab has produced an infectious clone of GLRaV-3, but must co-infiltrate with a silencing suppressor to get infection.

Tesneem Nusayr reported on her experiments that characterize the GroEL produced by the beet leafhopper. She showed that the endosymbionts from the beet leafhopper produce GroEl that differs from the GroEL from other hoppers. She showed through bacterial 2-hybrid and beta galactosidase production and PCR capture that the beet leafhopper GroEL binds to the curly top capsid protein, stronger than to begomovirus CP. The *E. coli* GroEL also binds to curly top CP, but not well to begomovirus. Expressed purified GroELs from both sources had the correct structure as visualized by TEM. There was interest from the group about producing transgenic plants containing GroEL to block leafhopper transmission.

Kylie Swisher discussed the role of beet leafhopper in BLTVA transmission. In northern Oregon, increased trap catches of BLH are found in June. Sugarbeet and radish are good hosts for the BLH and potato is an intermediate host allowing good survival. In 2007-2009 curly top was detected in the BLH. In 2002, potato purple top was found, which is caused by infection with BLTVA. It was not found for the next 10 years. In 2016, there was lots of BLTVA, but the distribution in the field was not the same as with the BLH and there were very low numbers of BLH. There were very high numbers of potato psyllids, suggesting that maybe they were transmitting BLTVA.

Kylie also reported on her work on a survey of peppers and weeds from central Mexico, Zacatecas state. She found BLTVA and curtoviruses and psyllids and leafhoppers. Sequence of the curtoviruses showed that they were PeCTV and PepSvr. She also found phytoplasmas in the psyllids collected from Zacatecas.

Quaid Dobey talked about his research, looking at the temperature and moisture requirements for Kochia germination from southern New Mexico. He found increased Kochia germination associated with a variable temperature regime of lower temperatures that was then transferred to higher temperatures, than when retained at the lower temperatures. He showed that there is very decreased germination with extremely high moisture stress. He found that the BLH feeding preference was to the largest Kochia in greenhouse and field cage experiments. He also found that Kochia emergence in the field is now 2-3 months earlier that it was 5-6 years ago.

Jennifer Willems gave an update on curly top in California and the control board management efforts. For updates on BCTV control in California, subscribe to BCTV at <http://www.cdfa.ca.gov/subscriptions/>. Sprays were done aerially on 64,450 acres in spring 2016, but there was no fall 2016 aerial campaign due to the large amount of rain. There was lots of rain in December 2016, which caused the growth of lots of grass and weeds in the foothills. The BLH did not appear to overwinter on the Central Valley floor. There was lots of rain in January and February 2017 also. There were minimal BLH numbers in Dec-Feb and weeds did not really dry down. Curly top was found in 33/46 leafhoppers and 17/113 plants collected from Fresno in March. There was no spraying other than roadsides in Fresno and Kings Co, and only 4,000 acres were sprayed in Kern Co.

Field reports of curly top were sent from Utah, by Claudia Nischwitz and from New Mexico sent by Stephanie Walker. Curtoviruses came in very late into Utah at the end of June and beginning of July. Individual fields had losses of up to 40% on tomatoes and 25% on gourds. Beans and beets also tested positive. In New Mexico, there was mid level severity of curly top with 3-5% infection in most locations and 10% in a few key growing areas. Some organic chile fields had 30% infection. A high level of infection, 40%, was found in transplanted chile at the university research farm, while adjacent direct seeded chile had very low levels of infection.

**Research Questions/Priorities –**

The group discussed the status of the disease, which research topics are important for a particular location and crop, and what our key research priorities would be. The list below is presented in no particular order.

Mapping of virulence factors in BCTV

Interaction between BCTV and resistance genes

Interaction between BCTV and different weed species

Prediction model for California, New Mexico

Quick field test for curly top for growers to use in the field for tomatoes

Clones of other curly top strains to allow a geographic location by strain analysis

Determine the driving force behind virus strain changes

Determine where leafhoppers are coming from when they move into the field. What is the scale of that movement? How far are they moving?

What strains of curly top should be expected if neonicitinoids are banned or lose efficacy?

Can we target vector transmission aspects to specifically interrupt transmission, perhaps using knowledge of GroEL?

There was a brief discussion as to the location for next year’s meeting. The preferred location was Davis, CA, 2nd choice would be Las Cruces, NM

**Tours-**

There was an excellent tour during our half day of meeting.

Horse Heaven Hills

Bean breeding plots (We found curly top and phytoplasma)

Medicago breeding cages, cherry trees and hops

Greenhouse with potyvirus resistance experiments

**Group Accomplishments**

Collaborative curly top projects for 2015-16 were carried out among Robert Gilbertson, Jennifer Willems, and Bill Wintermantel. Cooperative projects were carried out between Carl Strausbaugh, and Bill Wintermantel and between Carl Strausbaugh and Alex Karasev.

**Impact Statement**

The group has made an impact on better understanding and controlling curly top in the western U.S. The resistance of various crops and varieties to curly top was assessed, the curly top virus strains and virus prevalence for particular areas were characterized, and the relationship between viruses and specific weed hosts was assessed.

**Publications**

The group did not publish a report together.

Strausbaugh, C.A., Eujayl, I.A., and Wintermantel, W.M. 2017. Beet curly top virus strains associated with sugar beet in Idaho, Oregon, and a western U.S. collection. Plant Disease 101:1373-1382.