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

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**Summary of Meeting Minutes**:

Oliver Neher, Amalgamated Sugar, and host for the meeting welcomed the group to Boise to the Amalgamated Sugar Corporate facilities. Rebecca Creamer, WERA1007 Secretary, explained a bit about the group and its purpose. The group was recently renewed for another 5 years. Introductions were made, and the agenda was discussed.

The new Administrative Advisor for the group is Mary Burrows, Montana State University. She was unable to attend.

Rebecca Creamer presented background information on curly top and the beet leafhopper with emphasis on the disease in New Mexico in chile. She discussed the history of the disease in the state. She mentioned surveys of virus strains in sugarbeets and the frequency of recombinants and host specificity of certain strains. The most common weed hosts for the beet leafhopper in New Mexico are London rocket, which serves as an overwintering host, and Kochia, which serves as an oversummering host. She discussed the changes in timing of leafhopper flights and germination of Kochia from 2008 to the present, and how those might influence management. There was a brief mention of factors affecting virus titer in sugarbeets and how that can be manipulated to develop a virus-free leafhopper colony.

Hyoseok Lee spoke about his research on predicting spring migration time of the beet leafhopper using satellite imagery in California. Every spring beet leafhoppers carrying beet curly top virus (BCTV) are migrating from their overwintering sites (i.e., foothills) to crop fields in the valley floor in California. One of the factors triggering their migration is the vegetation conditions of the foothills. The migration pattern was monitored at the foothills in the San Joaquin valley for three years. We modeled the spring migration pattern based on enhanced vegetation index (EVI) calculated from satellite imagery. As EVI values decrease, more beet leafhoppers start migrating to the valley floor. The migration model is built as an interactive mapping system and will be published via Google Earth Engine.

Carl Strausbaugh reported that screening for resistance to *Beet curly top virus* (BCTV) in sugar beet suggests that at least some sources of resistance are strain specific. Also, beet leafhopper (BLH) populations can vary by location and year. Thus, at the request of a sugar beet industry stakeholder, BLH populations in southern Idaho were tracked during the 2020 growing season in desert areas and sugar beet and dry bean fields in four southern Idaho counties. Samples were collected on a weekly basis from May through mid-September to assess all leafhoppers for population levels and the presence of BCTV strains. Crop plants from monitored fields were also assessed for the presence of BCTV strains. BLH populations in Elmore Co. were present in at least double-digit numbers through most of the summer at all three sites. However, populations peaked in the Elmore desert (avg. 401 beet leafhoppers per 40 sq. inches) on 20 May, while populations in the bean field peaked in late Jun to mid-Jul (avg. 24) and the sugar beet field on 5 Aug (avg. 69). In the Twin Falls Co. desert, the BLH populations were low (high was an avg. of 3 in Aug) throughout the season. While the Twin Falls Co. sugar beet field peaked with an average of 27 BLH on 22 Jul and the bean field peaked with an average of 4 BLH on 15 Jul. In Minidoka Co. only a few BLH were collected at all three sites late in the summer. In Bingham Co. BLH at the desert and sugar beet sites were almost undetectable through the whole season. However, the Bingham Co. bean field had an average of 23 BLH by 26 Aug. Two haplotypes (based on cytochrome oxidase gene) dominate the BLH population. Over the 19-week collection period, the horizontal card averaged 82% fewer BLH than the vertical card. The BCTV strains found in the BLH population were as follows: Worland (95% of coat protein positive samples), Colorado (22%), Severe (2%), and CA/Logan (1%). The phytoplasma identification is currently a work in progress. Worland was the only BCTV strain found in bean plants. There were 2 BLH samples and 4 sugar beet samples that were positive for coat protein, but negative for the four strain specific primers. Once all data are collected, the project will establish the BCTV strains for which host plant resistance is needed and the best time for when control of beet leafhoppers is necessary.

Samuel Krasnobrod presented the California Department of Food and Agriculture Beet curly top virus control program. The 2021 field season has been characterized by dry conditions and relatively low beet leafhopper activity throughout the San Joaquin Valley. This limited activity resulted in lower-than-average acreage being treated during the spring aerial treatment campaign. As a comparison, 20,150 acres were treated during the spring of 2020, compared to the roughly 6,100 acres treated this year. Curly top virus induced crop damage was recorded across the Central Valley in 2021. This year saw unusually high instances of confirmed curly top damage of tomato crops in Colusa and Yolo Counties. Interestingly, both of these counties are located in the Sacramento Valley, which is further north of the region which typically experiences moderate-to-severe crop damage. Additional beet leafhopper and crop damage surveys will be needed to determine whether or not future curly top virus outbreaks can be expected in the Sacramento Valley. Looking forward, the Beet Curly Top Virus Control Program will continue to monitor these locations in Northern California where confirmed instances of curly top virus damage were recorded.

Marisa Thompson presented mid-season results from field trials looking at effects of row covers and kaolin clay on fresh market tomatoes on curly top and plant growth. She is in year 2 of a covered tomato study at the New Mexico State University Agricultural Science Center at Los Lunas, NM. Treatments include tomatoes covered with either 15% shade cloth or coated in kaolin clay film. The control group is comprised of uncovered tomatoes. All are the indeterminate hybrid ‘Big Beef.’ Along with mortality rates from *suspected* curly top virus infection, she is comparing midday stem water potential, canopy temperature, photosynthetic rate, yield, fruit quality (e.g., percentage with side-splits and shoulder cracks), and plant size. In year 1, cloth-covered plants were bigger and produced higher quality fruit, but yield differences were not detected, and only four plants died. So far in year 2 (2021), 27.8% of experimental plants have died.  As of August 1, 40% of the uncovered control plants, 43% of kaolin clay-coated plants, and 3% of the shade-covered plants were dead. Efforts to formally diagnose plants with the curly top virus versus other possible ailments continue.

At the WERA 1007 meeting, attendees answered questions about testing plant tissues for curly top, curly top transmission concerns, and next steps for future research. Later that week, information was shared with the public via the weekly Southwest Yard & Garden newspaper column titled, “Straight Answers to Curly Questions” ([https://nmsudesertblooms.blogspot.com/2021/07/straight-answers-to-curly-questions.html](https://nam10.safelinks.protection.outlook.com/?url=https%3A%2F%2Fnmsudesertblooms.blogspot.com%2F2021%2F07%2Fstraight-answers-to-curly-questions.html&data=04%7C01%7Ccreamer%40nmsu.edu%7C124864d58b0649d711fc08d95706702b%7Ca3ec87a89fb84158ba8ff11bace1ebaa%7C1%7C0%7C637636507424944929%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=lrZoGUmA9dISeUGRO3d9FojJTZQjUx7c7QtmXxPMQ8I%3D&reserved=0)).

Punya Nachappa, in cooperation with Judith Chiginsky, Tyler Yamashita and Laura Newhard, who attended in person presented data on curly top infection of hemp in Colorado. Hemp (*Cannabis sativa*) production has increased significantly in recent years; however, the crop has been understudied in the U.S. since its production declined in the late 1950s. Disease identification and management is an increasing challenge for hemp growers across the country. Beet curly top virus (BCTV) was first reported in hemp in 2019 from Colorado, the goal of this study was to understand the diversity and prevalence of specific strains of BCTV in hemp. There was a high incidence rate of BCTV (81%) from the 12 counties sampled using species specific primers. All BCTV-positive samples tested positive for BCTV-Worland, BCTV-Colorado or were co-infected with the two strains. A range of symptoms was observed on hemp including yellowing, stunting, curling and twisting. To rule out the presence of other viruses in the hemp samples, shotgun metagenomic analysis was performed on 6 out of 12 hemp samples, revealing 8 viruses and 1 viroid. Phylogenetic analysis revealed BCTV sequences from hemp formed a distinct group along with BCTV-Colorado strains in Genbank. In a separate study, we evaluated resistance in leafhoppers to a neonicotinoid, Poncho Beta and two commonly used pyrethroids, Mustang and Asana. Preliminary results suggest that no resistance to Poncho Beta, but we observed resistance to Mustang and Asana at the labeled rate. The outcomes of this study will inform growers about insecticide resistance in leafhoppers and help growers explore alternate pest management strategies for curly top control.

Ana Cristina Fulladosa Palma presented on developing a seed/seedling certification system for Colorado hemp. There were 20,000 acres of hemp grown in Colorado in 2020. Several groups (Colorado Dept. of Ag., Assoc. of Seed Certifying Agencies, Colorado Seed Growers Assoc., CSU Plant Diagnostic Clinic) are working together to develop a certification process for hemp cuttings or seed derived from a stable mother plant of a specific variety with a unique phenotype. The process currently under development is being expanded to include virus and viroid testing. The steps are: Breeder provides botanical description of a variety that includes physical traits and shows ownership of the variety. The variety will be grown in tissue culture to maintain phenotype. Tissue culture plantlets will be grown in a greenhouse and it and its cuttings will be inspected for compliance with the description and no disease symptoms or arthropod infestation. Both plantlets and cuttings will be sent to the CSU Diagnostic Lab and tested for viruses and viroids, specifically beet curly top virus, tobacco streak virus, and hop latent viroid. If everything passes, the seedlings will be certified.

Various participants presented field perspectives from different states.

Idaho – There have been changes in the hopper numbers at particular locations, some are weather related, but changes have been seen under normal weather conditions. There were also almost no winter annuals during the past year. There have also been changes in the virus strains found in the field. Some of this could be due to the extensive use of neonicitinoids for seed treatment.

California – There was an outbreak of curly top much further north than is usual. There are also still periodic problems with curly top in the Imperial Valley area.

Can we predict leafhoppers populations based on spikes in late fall leafhopper numbers? What factors influence a large fall leafhopper population? Carl found a large number of leafhoppers in Idaho in fall 2019 that correlated with dry down of weeds. However, Idaho had a strong cold snap that likely killed everything in October and little rain afterwards. Rebecca found a very similar trend in New Mexico in fall 2020. Very few leafhoppers in 2021 and very late Kochia emergence.

Research Priorities and Ideas

-Novel genetics for disease resistance and genetic markers for the resistance. Resistance to early infection would be particularly helpful.

- Would like a better understanding of resistance mechanisms, all types.

- How efficacious is malathion for curly top management in California?

- What is the role of acyl sugars in resistance to leafhoppers or leafhopper non-preference?

Punya Nachappa suggested that the WERA1007 group should apply for an SCRI (Specialty Crop Research Initiative) CAP (Coordinated Agriculture Projects) grant for one of the crops that is a problem for curly top, such as peppers, tomatoes, beans or other specialty crops. Christian was supportive of the idea.

There was a brief discussion as to the 2022 meeting location. Punya Nachappa volunteered to host the meeting. The meeting date will tentatively be set for a hybrid meeting (online/in person).