

Arizona Pest Management Center IPM Project Final Report

Integrating Monitoring, Global Information System (GIS) and Geostatistics for the Management of the Whitefly vectored disease, Cucurbit Yellow Stunting Disorder Virus (CYSDV) in AZ Melons
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Overview of Problem: The Cucurbit Yellow Stunting Disorder Virus (CYSDV), genus *Crinivirus* and family *Closteroviridae*, has emerged as an extremely serious whitefly-transmitted virus of cucurbit crops within Arizona. The virus causes prominent interveinal chlorosis, shortened internodes and leaf brittleness. In the fall of 2006, CYSDV was first confirmed in Arizona causing an estimated 60 – 70% reduction in marketable melon yield. Economic damage estimates from the Arizona Department of Agriculture (AZ Ag Stats Bulletin, 2006) showed fall, 2006 CYSDV outbreak resulted in a \$14 million loss in melon production within the Arizona. As Yuma County produces approximately 75% of the melons within the state (AZ Ag Stats Bulletin, 2006), management and control of CYSDV within the Yuma region is viewed by many as a critical need for overall state melon production.

Protocol: By Mid-March, 2008, we placed 105 yellow sticky traps for whitefly capture and monitoring within the melon producing areas Yuma County (Figure 1). The unique setting created an interesting research dynamic as the region contained the complexities of an urban center (The City of Yuma), an international border (Mexico), significant melon production (~3,000 melon acres in 2006), topographical elements (Gila and Mohawk Mountains), a river influence (Colorado and Gila Rivers), uninhabited desert areas and the interplay within a transition between the huge variety of agricultural commodities

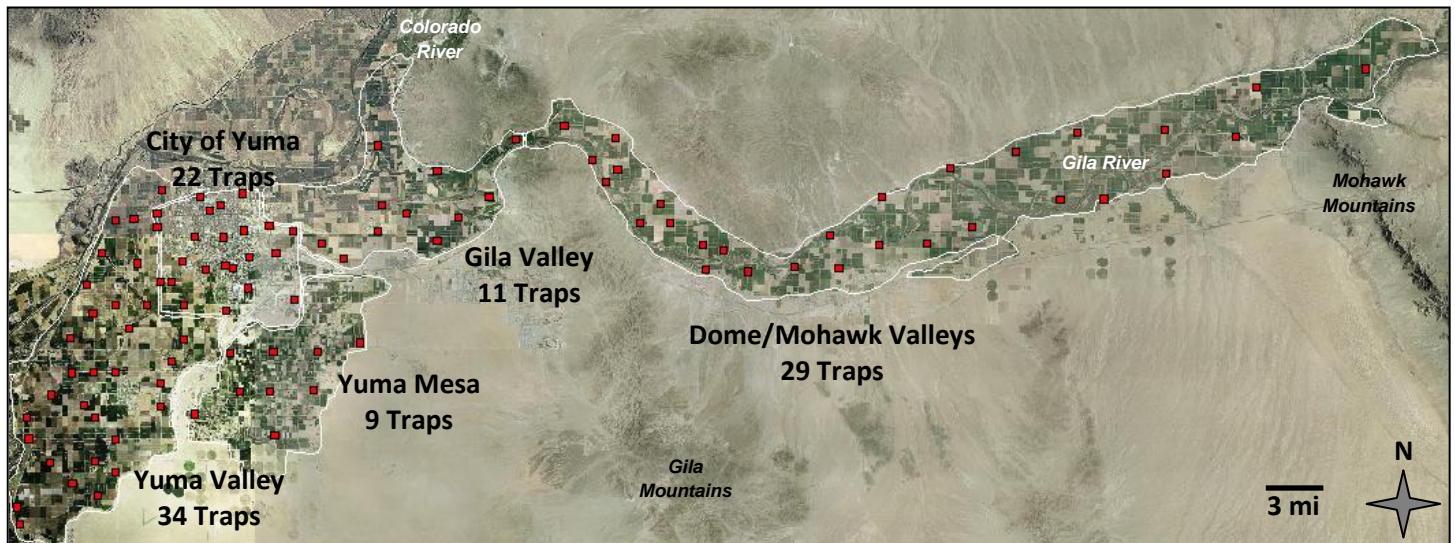


Figure 1. Distribution of yellow sticky traps within the 2008 Yuma County whitefly trapline.

grown in the area (fall and winter vegetables, citrus, alfalfa, small grains and cotton). The 200,000 acre study area encompasses 4 valleys (Yuma, Gila, Dome and Wellton-Mohawk), the Yuma Mesa, areas surrounding the Colorado and Gila rivers and the City of Yuma. Based on trap counts, yellow sticky traps were deployed, maintained and captured whiteflies tabulated at biweekly intervals in these areas to capture flying whiteflies for monitoring adult densities under field conditions. Spring and fall melon fields were monitored for the presence of CYSDV on a biweekly basis and field symptoms were rated

for severity (1, asymptomatic; 2, yellow spotting; 3, interveinal chlorosis; 4, chlorotic leaves; 5, field level CYSDV).

Geospatial analysis of whitefly trap counts was conducted using a combination of geospatial mapping software (Farmworks®) and a statistical package (SAS®). Each trap and melon fields were georeferenced with a hand-held global positioning unit in the universal transverse mercator (UTM) coordinate system to be used in geostatistical analysis.

Outputs: The long-ranging objectives of this program benefited regional melon producers in the following 4 ways:

1. *Whitefly Temporal, Spatial and Density Mapping.* By monitoring whitefly populations at specific locations within an intricate agricultural region, the construction of weekly whitefly density maps, provided an overview of the yearly migration patterns of the insect and how they are influenced by the intricacy of the area. This was particularly evident during the 30-day, 2008 cucurbit host free period (5 July – 5 August, 2008) as shown in Figure 2.

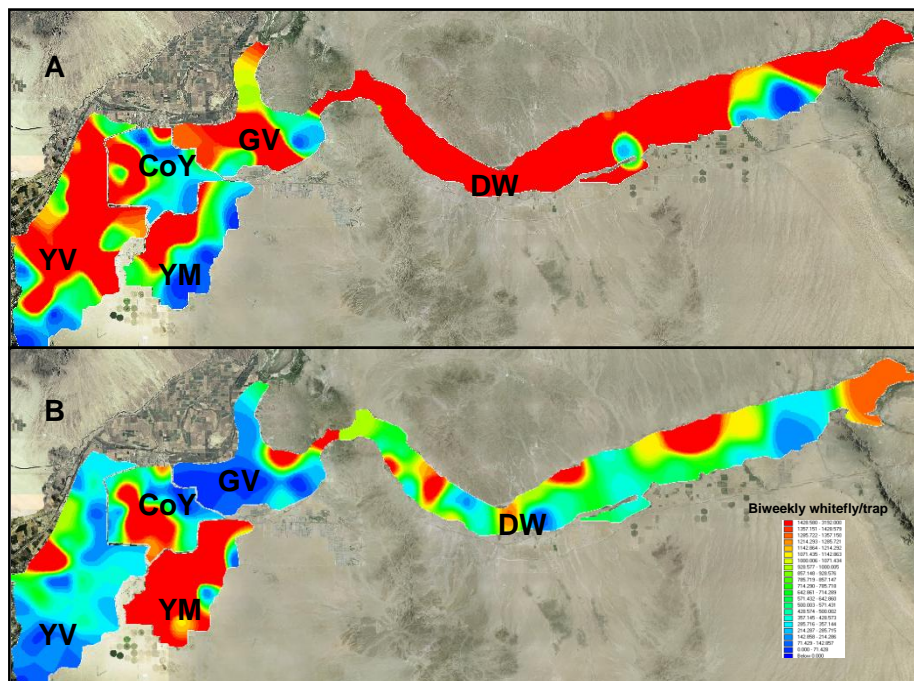


Figure 2. Whitefly distribution during the voluntary cucurbit plowdown (A) and after (B). Note the impressive population reduction of whiteflies in the melon production areas of the Yuma Valley (YV), Dome/Wellton (DW), and the Gila Valley (GV). Also noteworthy is the prominent increase in whitefly numbers within the Yuma Mesa (YM) and the City of Yuma (CoY) regions following the cucurbit host free period.

Following the cucurbit host free period, significant regional reductions in whitefly was observed, yet the City of Yuma and Yuma Mesa areas increased (YM) or maintained (CoY) whitefly numbers. It appears that whitefly dispersal during periods of crop host removal significantly impacts other regions within a geographic area.

2. *CYSDV Surveillance Workshops.* A detailed use of CYSDV incidence maps will be used to illustrate the spread of CYSDV over a regional scale, integrating cropping patterns, cucurbit

plow down episodes and whitefly vector densities with disease occurrence. The compilation of 2008 results from this and other CYSDV projects in the region is slated for January 14, 2009.

3. *Whitefly Migration Patterns Within and Around Urban Settings.* It is not currently known how urban dwellers influence the whitefly population and movement dynamic. Thus, screening whitefly populations within an urban landscape could provide keys to the management of this disease. However, during periods of a cucurbit plow down (Figure 3), it seems clear that whitefly dispersal from agricultural areas includes an overall increase in urban whiteflies, especially those areas immediately adjacent to the Yuma Valley. In fact, when specific directional whitefly counts were made (Figure 3), whitefly migration appeared to enter the urban setting from the West countering the notion that urban migration of whitefly to agricultural areas.

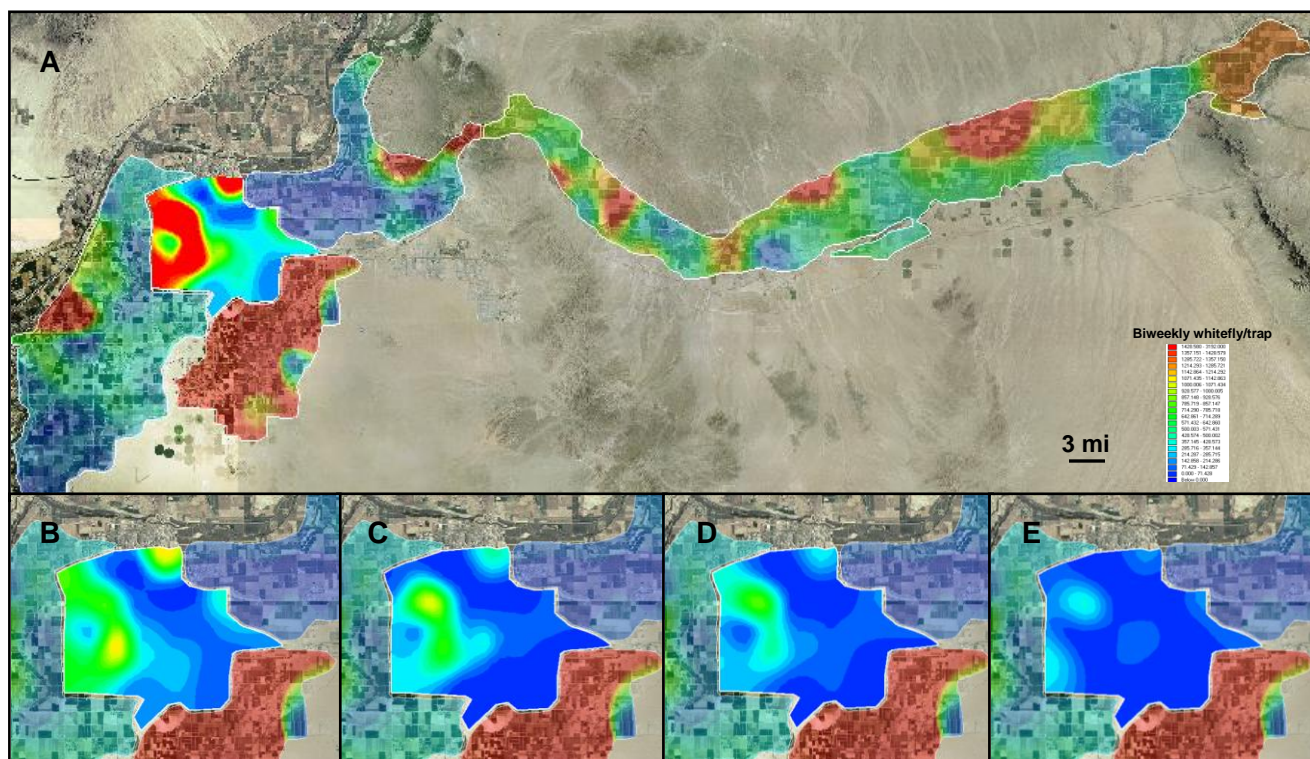
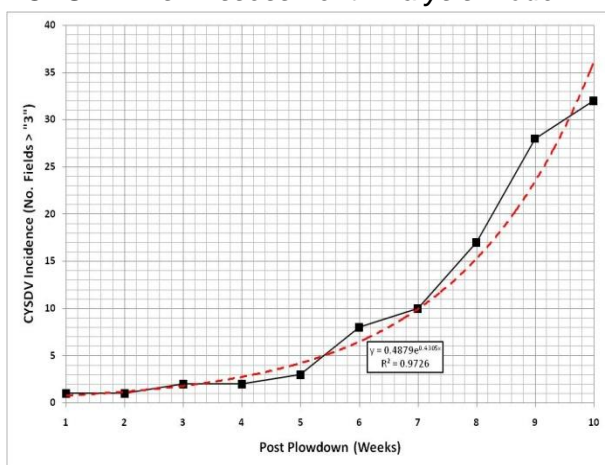


Figure 3. Whitefly distribution following the voluntary cucurbit plowdown in the summer of 2008. Note the population increase of whiteflies in City of Yuma despite the overall reduction of whitefly in the agricultural areas. When whitefly counts were made directionally (B, west facing traps; C, south facing traps; D, north facing traps; E, east facing traps), fewer whitefly were captured in east facing traps than any other direction, suggesting a significant influence of agricultural production to the west of this urban center.

4. *A CYSDV Risk Assessment Analysis Model.* Through an iterative process of comparing



spatial data on risk with observed incidence, our understanding of the spatial and temporal aspects of disease processes improved our ability to produce maps useful to melon producers.

Vanderplank (1963) described the well understood polycyclic disease progress

Figure 4. The incidence of CYSDV (■) in Yuma County in fall, 2008, including an overall exponential trend in occurrence (- - -).

model which describes the exponential buildup as an indicator of disease progress. We found that this convention, essentially basing the exponential buildup of disease on a constant, r , the “apparent infection rate” (Figure 4) was consistent with the polycyclic form of CYSDV disease spread. Graphically the model has the familiar form of the exponential model as used in the growth rate function. We used a similar approach to solve for the rate of inoculum production in both spring and fall whitefly population growth curves (Figure 5). Based on data collected immediately following a cucurbit host free period and the subsequent reduction of whitefly populations, the rate of CYSDV inoculum dropped from 0.42 to 0.19. Although preliminary the results suggest that there is a significant reduction (55%) in inoculum rate attributed to the slowdown period.

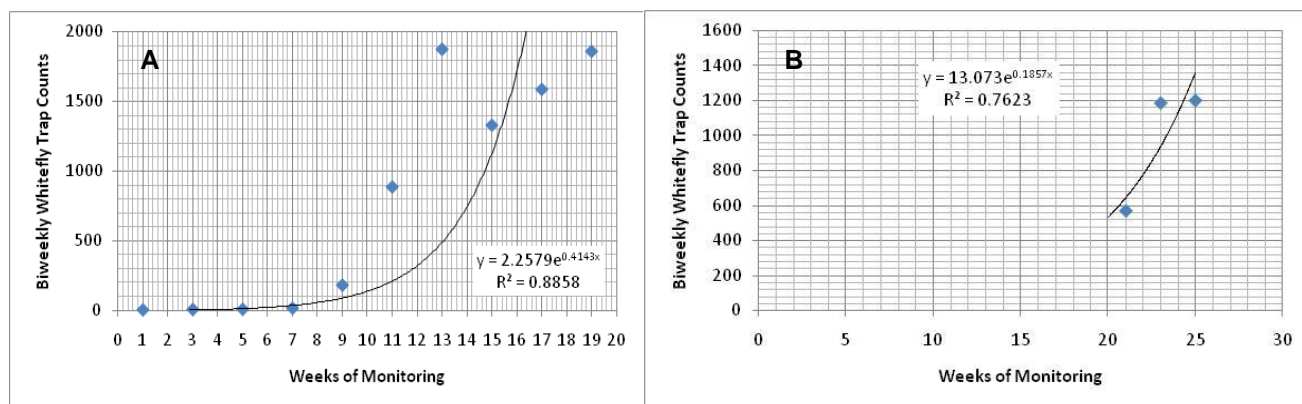


Figure 5. The exponential increase of whiteflies in Yuma County in 2008. Spring CYSDV inoculum rate (A), calculated as the slope of the exponential curve (0.42) was twice the rate of inoculum production followed by the cucurbit host free period observed in the following fall.

Conclusions

1. Urban whitefly numbers peaked in July corresponding with the voluntary termination of commercial melon production in agricultural areas.
2. Significant commercial production in western regions of Yuma influences the general whitefly population in the city, especially those immediately adjacent to agricultural areas.
3. In addition to whitefly movement within an urban area, agricultural activity could dramatically affect whitefly population dynamics within specific regions of a city.
4. In the absence of agriculture, it appears that city whitefly population dynamics can be independent of those found in agricultural regions.
5. CYSDV infection progress appears to be polycyclic in nature and requires a secondary source of inoculum for disease spread during the season. The occurrence of CYSDV can be described as being exponential and has many infection cycles throughout the season, particularly in the fall when whitefly numbers are high.
6. Dispersal of secondary inoculum, and the establishment of new infections and, therefore, control strategies for CYSDV should be targeted towards reducing the number of secondary cycles and/or the rate at which they occur.
7. Disruption of viral-host-vector cycles can impact subsequent increases of vector populations and reduce the inoculum rates and appears to be an advisable control strategy for the management of CYSDV.

References Cited

Vanderplank, J. E. 1963. *Plant Diseases: Epidemics and Control*. Academic Press, New York.