Preliminary Investigation of Sweet Potato Whitefly Population Dynamics Across Arizona

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Abstract

The sweet potato whitefly can have an impact on cotton by reducing yields through direct feeding damage, by transmitting the cotton crumple leaf virus during feeding and by the production of large amounts of sticky honeydew that interferes with the harvesting and ginning process. Data on whitefly populations collected weekly from 938 yellow sticky traps near cotton fields have been entered into a geographic information system (GIS) database. In general, whitefly populations were high near cotton fields in the Yuma area before July 6th. They rose rapidly in central Arizona between July 6th and July 20th. During the month of August, counts continued to rise in central Arizona, particularly in western Pinal County. Populations began to fall during October. Whitefly populations in eastern La Paz County were slower to develop than in other areas in western Arizona. Whitefly populations in Graham and Cochise County were not significant throughout the growing season. Cotton crumple leaf virus was observed in parts of central and western Arizona.

Introduction

In recent years the sweet potato whitefly has had a significant impact on Arizona agriculture. Damage associated with the sweet potato whitefly has been well documented (Byrne et al. 1990, Johnson et al. 1993). Whiteflies cause reduced yield due to 1) extraction of phloem sap, 2) contamination of plant material by sooty mold fungi (*Capnodium* spp.), 3) interference with harvesting and ginning because of honeydew contaminated fibers, and finally, 4) reduced yields due to the cotton crumple leaf virus (Brown, Mihail and Nelson 1987). In the past, we have not had a broad overview of whitefly population dynamics statewide. The collection of these data will allow us to make statements in the future about the statewide dynamics in whitefly populations and how they relate to changes in climate and cropping patterns. Observations on cotton crumple leaf virus will allow us to assess the impact of this disease in relation to the timing of the whitefly population buildup.

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Materials and Methods

Southwest Boll Weevil Program personnel (SWBW) positioned yellow sticky traps weekly near 938 randomly selected cotton fields throughout the state. The 6 inch by 12 inch traps were fashioned in a cylindrical configuration and placed at a height of 24 inches just outside the cotton field, usually near the northeast corner. Traps were collected weekly and the number of sweet potato whiteflies in five randomly selected square inch sections were counted from each trap. Data were summarized as the mean number of whiteflies per square inch of trap surface. Occasionally, traps were not counted for a particular location because they were missing or covered with dirt. Data were collected from most locations between June 15th and October 30th.

Analyses of spatial patterns were done using the geostatistical program, GeoEAS, and the geographical information system (GIS) program, ARC/INFO. An estimate of universal transverse mercator (UTM) coordinates for each trap location was made using the township maps of cotton fields provided by SWBW. This allows trap locations to be displayed on computer generated maps as overlays (Figure 1) with other GIS data such as state and county boundaries, river systems, interstates etc. that are available in GIS format from the Arizona Land Resource Information Service (ALRIS) of the Arizona State Land Department. To visualize regional patterns of whitefly trap data, average values for 5 km by 5 km square grid cells are computed using the GeoEAS kriging program. Kriging is a method for computing a weighted moving spatial average in which the values being averaged (whitefly counts) are weighted using an algorithm that depends upon the locations of the sample sites and the spatial structure of the variable being measured.

Beginning in mid-August, photographs of cotton plants showing typical symptoms of cotton crumple leaf virus were given to SWBW personnel collecting the yellow sticky traps. They reported cotton fields with plants showing symptoms of cotton crumple leaf virus. Plant pathology researchers visited selected sites to verify the observations. The coordinates of locations where the virus was observed were entered into the GIS database.

Results and Discussion

Data were collected from 938 traps weekly for 21 weeks, so only a subset of the data can be displayed here. The data can be displayed in two ways, temporally in specific areas or spatially at specific times. A temporal display shows whitefly population trends near cotton fields in the Dome Valley, northwest of Casa Grande and near Marana (Figure 2). These areas are representative of cotton growing areas across the state. The temporal trends in Figure 2 can also be seen by comparing the regional maps of showing the spatial pattern of whitefly populations at six different time periods from July 6 through October 26. Average trap counts from Graham and Cochise County were under 1 whitefly per square inch of trap surface until the week of October 19 when eight traps in a 5 km by 6 km area near Safford averaged seven whiteflies per square inch of trap. Because of the low average counts, those areas are not shown in Figures 5 through 8.

The data collected are from traps located outside of the cotton fields and are not always indicative of populations within the field. They may reflect immigration of whiteflies from surrounding crops or emigration resulting from the termination of irrigation or defoliation as well as other movements of whiteflies in area around the field. Therefore, some of the regional patterns seen in the figures are caused by differences in planting dates and termination dates of the cotton crop. In general, Figures 3 and 4 show that whitefly populations were high near cotton fields in the Yuma area before July 6th and that they were rising rapidly in central Arizona between July 6th and July 20th. During the month of August, counts rose in central Arizona, particularly in western Pinal County (Figures 5 and 6). During August and September, the center of the highest populations shifted to the east (Figures 5, 6, and 7). Populations began to fall during October (Figure 8). Whitefly populations in eastern La Paz County were slower to develop than in other areas in western Arizona (Figure 5).

The cotton crumple leaf virus is a gemini virus transmitted by whiteflies. It is of particular concern when whitefly populations reach high levels early in the year because the earlier that the cotton plant is infected the greater the impact on yield (Brown, Mihail, and Nelson, 1987). Cotton crumple leaf virus symptoms were seen in a number of areas in central and western Arizona where whitefly populations were high (Figure 9). However, they were not seen in all areas with high populations of whiteflies. For cotton crumple leaf virus to be a problem, the virus must be present in alternate hosts including weeds (such as *Malva parviflora*) in order for the whitefly to move the virus into the crop. The dynamics of whitefly populations and disease incidence is one of the long term goals of this study. By comparing the spatial pattern of whitefly populations with those of disease incidence over several years, we hope to be able to better assess the long term impact of this disease on the state's cotton crop.

The data collected this year have been entered into a GIS database. The data can be analyzed in the context of other spatially referenced data such as river drainages, elevation, proximity to urban centers, weather data etc. The GIS system can be used to display information at various scales from an area of local interest or to the entire state. The information presented here is only preliminary because we have just begun to bring together the range of spatially referenced data from other sources available to compare with the data collected this year. Rainfall, winter temperatures, alternate hosts, and crop sequencing all change from year to year in a way that affects the statewide pattern of whitefly populations. Being able to compare information from one growing season to the next should help us assess management strategies in the appropriate spatial context. In a separate project it has been shown (Nelson and Stowell 1989) that the crumple leaf virus moves within a cotton field mostly from plant to plant therefore we feel that the migratory characteristics of the whitefly and the proximity of the virus alternate hosts is crucial to the potential management approaches to preventing virus infection.

References Cited

Brown, J. K., J. D. Mihail, and M. R. Nelson. 1987. The effects of cotton crumple leaf virus on cotton inoculated at different growth stages. Plant Disease 71:522-524.

Byrne, D. N., T. S. Bellows and M. P. Parrella. 1990. Whiteflies in agricultural systems. pp. 227-261 in D. Gerling (ed.) Whiteflies: the bionomics, pest status and management. Intercept, Andover, U. K.

Johnson, M. W., L. C. Caprio, J. A. Coughlin, B. E. Tabashnik, J. A. Rosenheim and S. C. Welter. 1992. Effect of *Trialeuroides vaporariorum* (Homoptera: Aleyrodidae) on yield of fresh market tomatoes. Journal of Economic Entomology 85: 2370-2376.

Nelson, M. R. and L. J. Stowell. 1989. Dispersion characteristics of a whitefly transmitted geminivirus in the field. Phytopathology 79:1219(abstr).

Figure 1. Location of whitefly traps in Arizona

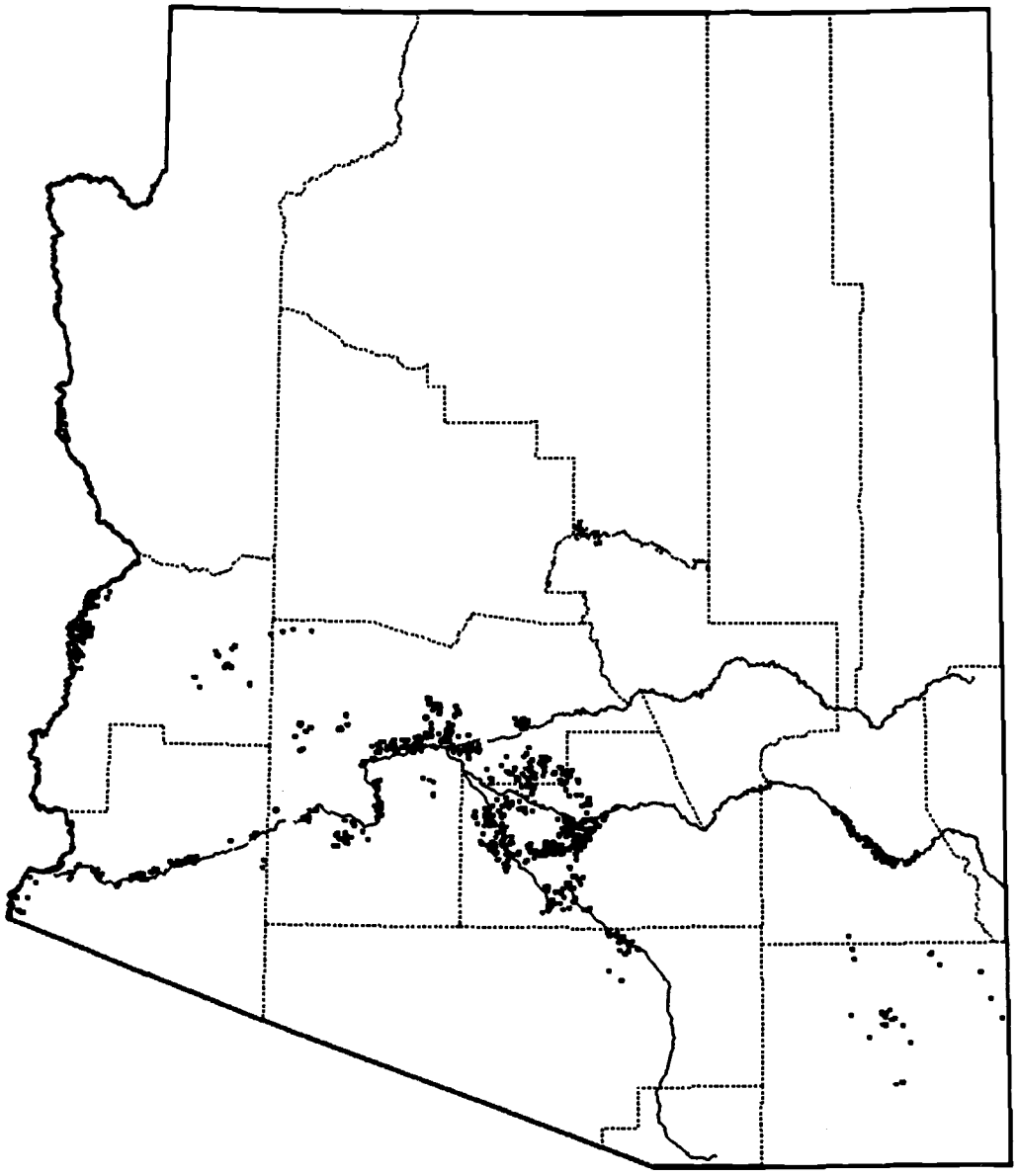
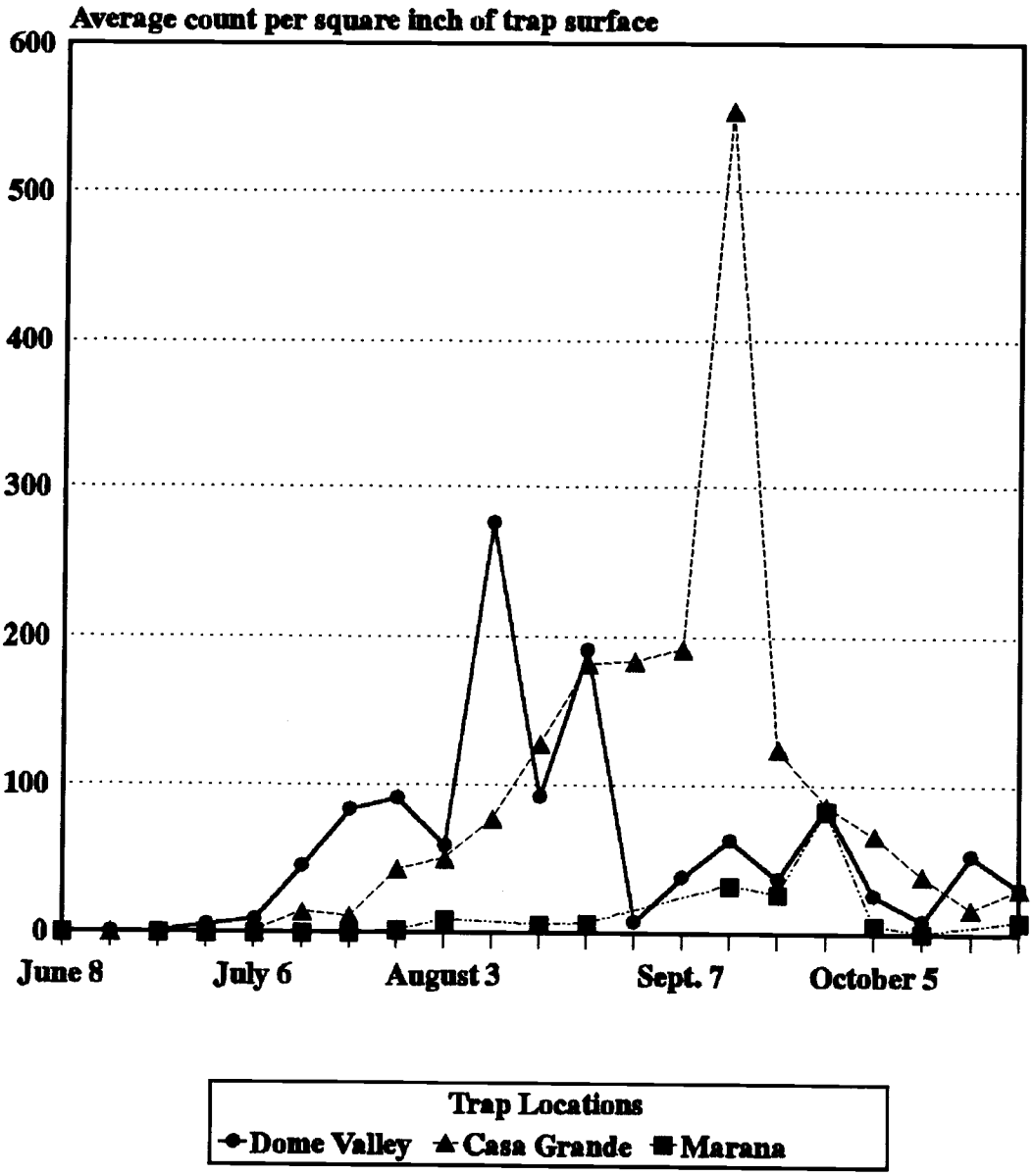


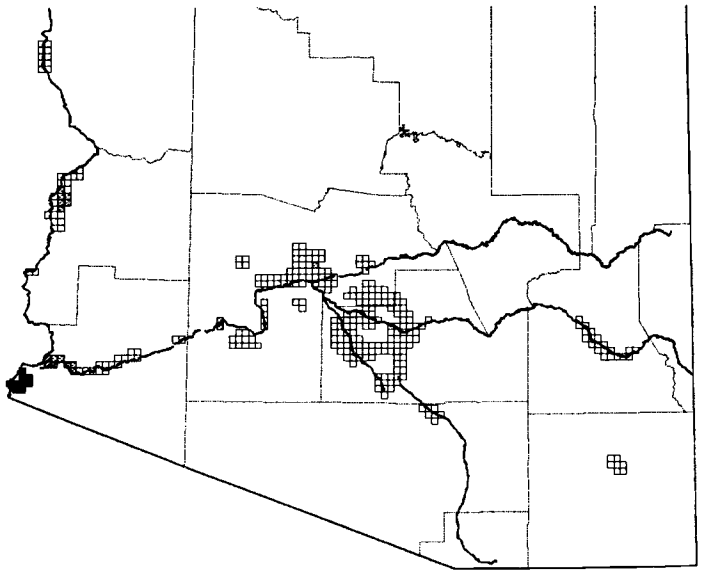
Figure 2. Whitefly populations changes in Arizona during 1992

Whitefly trap counts from three representative areas



Regional pattern of whitefly trap counts near cotton fields in 1992

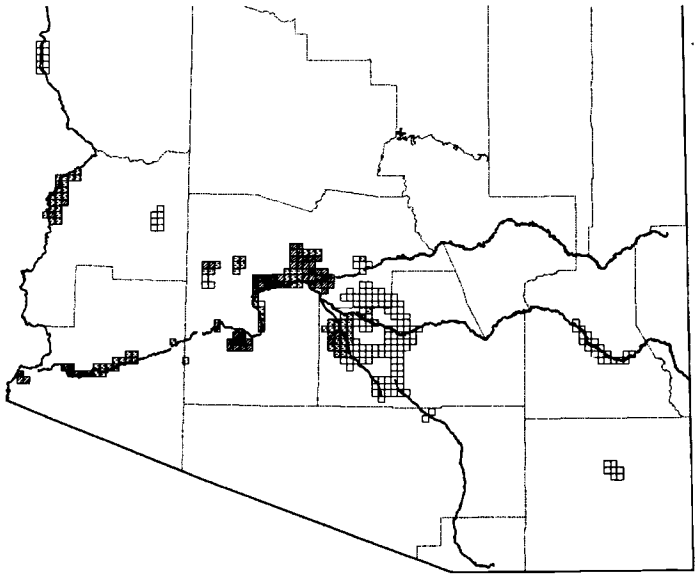
Figure 3. Southern Arizona. Week of July 6.



Key:
Grid cells are 5 km square. They show the average number of whiteflies per square inch of trap.

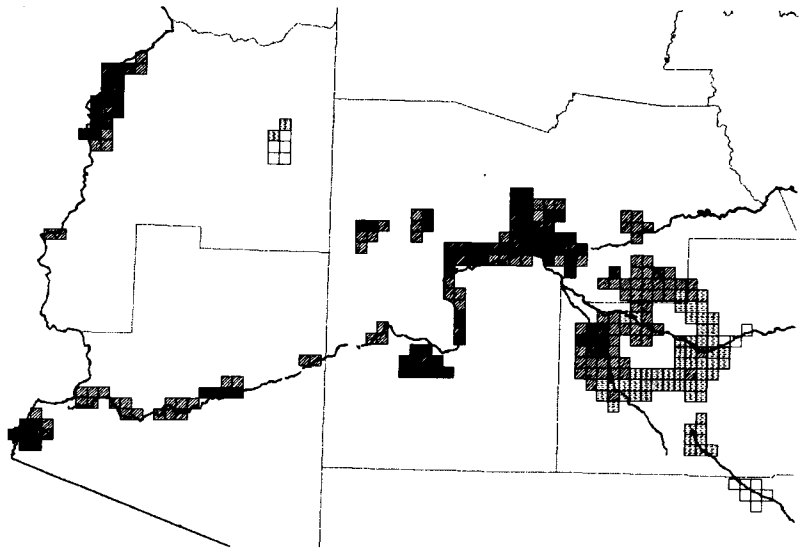
- 0 to 5
- 5 to 25
- 25 to 75
- 75 to 150
- more than 150

Figure 4. Southern Arizona. Week of July 20.



Regional pattern of whitefly trap counts near cotton fields in 1992

Figure 5. Central and western Arizona. Week of August 3.

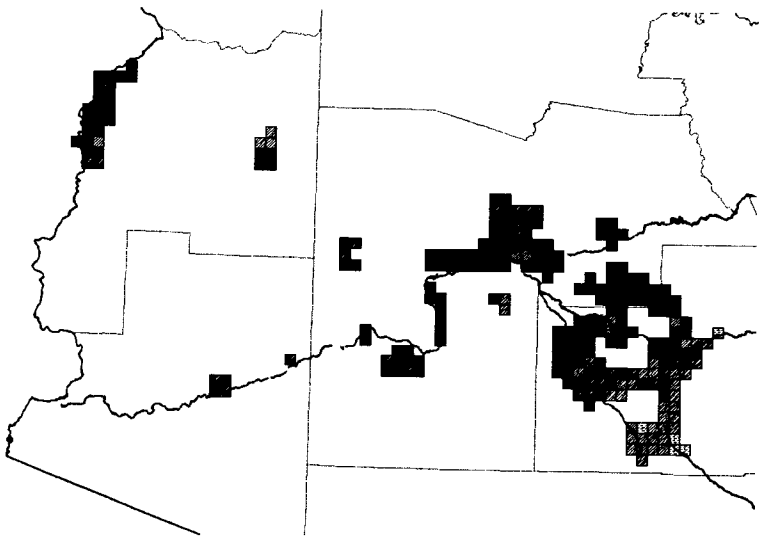


Key:

Average number of whiteflies per sq. in. of trap.

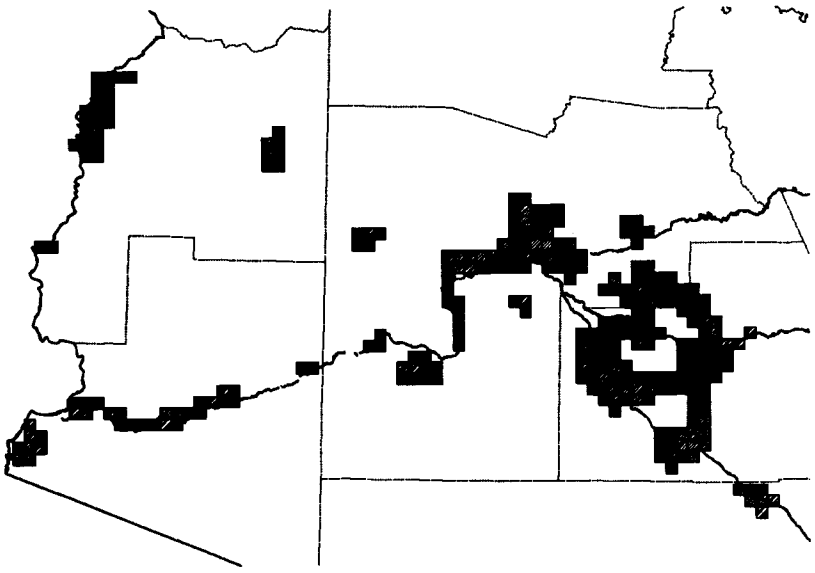
- 0 to 5
- 5 to 25
- 25 to 75
- 75 to 150
- more than 150

Figure 6. Central and western Arizona. Week of August 31.



Regional pattern of whitefly trap counts near cotton fields in 1992

Figure 7. Central and western Arizona. Week of September 28.



Key:

Average number of whiteflies per sq. in. of trap.

- 0 to 5
- 5 to 25
- 25 to 75
- 75 to 150
- more than 150

Figure 8. Central and western Arizona. Week of October 26.

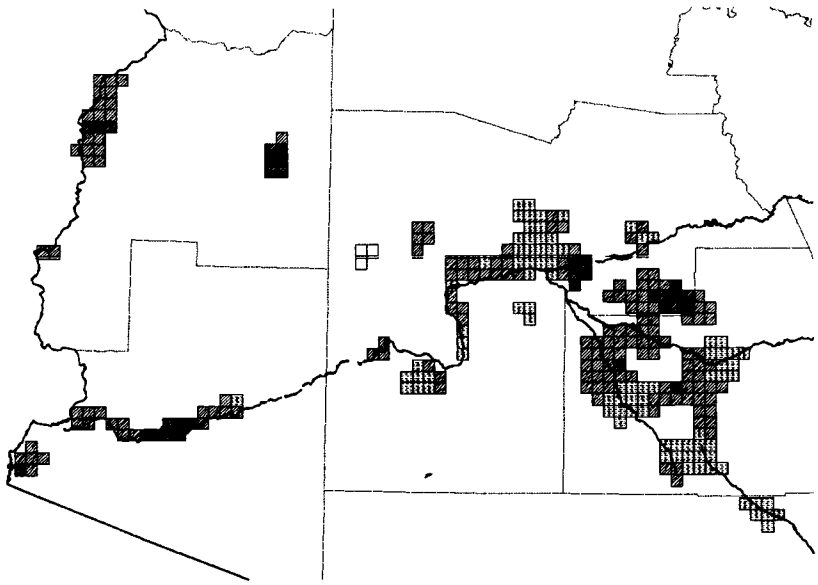


Figure 9. Cotton Crumple Leaf Virus Distribution in Arizona.

Shaded areas indicate where cotton crumple leaf virus was seen in 1992.