COTTON VIRUS DISEASES

M. R. Nelson, A. Nadeem, W. Ahmed, and T. V. Orum
Department of Plant Pathology, University of Arizona, Tucson, AZ; Central Cotton Research Institute(CCRI), Multan Pakistan; and Ayub Agricultural Research Institute(AARI), Faiselabad, Pakistan.

Abstract

Virus diseases of cotton have historically been of only sporadic importance to global cotton production. Recent devastating epidemics in Pakistan and other areas have brought new awareness to the potential for disaster of a pathogen once considered to be of a minor importance. Under changing conditions this pathogen(cotton leaf curl virus) has emerged as a serious problem in Pakistan and India. Cotton leaf curl virus does not occur in the United States or the rest of the western hemisphere but recent experience worldwide is a reminder that pathogens, such as this geminivirus, can be moved easily from one part of the world to another and therefor we need to be aware of the potential impact of such pathogens on local crops.

Introduction

While over 20 virus diseases of cotton have been described in the American Phytopathological Society, "Cotton Disease Compendium", only a few have actually been shown to be of virus etiology. The main ones, so proven, include several geminiviruses (Brown and Nelson 1984, Mansoor et. al. 1993 and Nadeem et al. 1997), and tobacco streak virus (Cauquil and Folin, 1983, Ahmed and Nelson 1997).

The Viruses

Geminiviruses.

The geminiviruses that infect cotton are leaf crumple and leaf curl. Leaf crumple is found in the Southwestern USA and Central and South America, while leaf curl has been described in Africa and Asia. These viruses are quite different when the DNA sequences are compared (Nadeem et al.) and produce different symptoms in the field. Leaves on cotton plants infected with leaf curl, curl upward, have swollen veins, and enations growing out from the leaf nectaries. Leaves on leaf crumple infected plants, in contrast, curl downward giving the crumpled effect. In addition, enations may be present on flowers of leaf crumple infected plants.

While both viruses can cause severe losses when infections occur on young plants, lint produced on leaf crumple infected plants, even though reduced in quantity, is not affected in important quality measures. Leaf curl infected plants produce no useful lint.

These two cotton geminiviruses have been sporadically important over the years. Leaf crumple, first described in the 1950's in the US, is a problem when cotton is grown as a perennial, or is planted late or near spring vegetables supporting high populations of whiteflies. Leaf curl has been a problem in African cotton producing areas since at least the early 1900's. The virus was also noted in Pakistan in the 1960's, but considered to be a minor problem until the late 1980's. At that time, a new high yielding cotton variety, S-12, was introduced. This variety was extremely susceptible to the leaf curl virus and is believed to have played a key role, along with changes in the population structure and dynamics of the whitefly vector, *Bemisia tabaci,* in elevating this virus from a minor to a major problem.

Cotton mosaic

This disease, caused by tobacco streak virus(TSV), has recently been found to be widespread in Pakistan. Like leaf curl, it too has a long history in Africa and elsewhere. Tobacco streak virus can be diagnosed easily using an ELISA system, is readily transmitted in sap and has been shown experimentally to suppress cotton plant productivity when infections

occur early. The virus was widespread in the Punjab in 1997. The method of transmission under field conditions has not been worked out for TSV in cotton. Attempts to experimentally transmit the virus by thrips, as is the case in some other members of this group(Ilarviruses), has not yet been successful.

Varietal susceptibility

Despite the fact that cotton mosaic is still considered to be a minor problem where it is known to occur(Pakistan Brazil and Africa), some interesting data on varietal susceptibility are now available. For example, the S-12 variety that is extremely susceptible to leaf curl is resistant to TSV. In addition, some other varieties of Pakistan cotton that are resistant to leaf curl are susceptible to TSV. The following cotton varieties are resistant(immune) to leaf curl after multiple location field trials and greenhouse tests by grafting and whitefly transmission tests; CIM 434, 435, 443, 445, 448, 1100, LRA-5166, BH-100, FH-634, VH-53, and VH-55. These same varieties are all susceptible to TSV.

In contrast the following varieties are highly resistant to TSV but highly susceptible to leaf curl; CIM-70, S-12, B-622, B-30, B-496, BH-4, BH-89, BH-94, BH-95, and Krishma. A number of other varieties are susceptible to both viruses.

Spatial analysis of cotton virus epidemics

Both leaf crumple and leaf curl, show a marked patchiness in their distribution on a regional scale. This patchiness is emphasized by a geostatistical analysis of data collected in the state of Punjab, Pakistan. Geostatistics provides tools to analyze data that has spatial autocorrelation. Spatial autocorrelation occurs when nearby points are similar in value. Many variables will show spatial autocorrelation at more than one scale. One of the more popular geostatistical techniques is called Kriging. Kriging refers to a group of linear regression techniques that use models of the spatial autocorrelation to estimate values at unsampled locations(Myers, 1991).

Arizona leaf crumple situation in 1996 and 1997

Leaf crumple infection was the heaviest in recent years in central and southwest Arizona in 1996. Plants in some fields in the Eloy, Casa Grande, Stanfield, Gila Bend, Maricopa and Texas Hill areas were found in early September to exhibit leaf crumple symptoms in 40 to 80 per cent of the plants. Several fields near Tolleson, in a spring melon producing area, west of Phoenix, were found to be 100 per cent infected by mid August. These fields appeared to suffer significant production losses. Buckeye Valley and the area south to Gila Bend had only a small number of symptomatic plants.

In 1997, cotton plants with leaf crumple symptoms in all of these areas were hard to find even in mid September. There are a number of possible reasons for this dramatic difference in the incidence of cotton leaf crumple infected plants between 1996 and 1997. The most likely, in our opinion, is that though there were judged to be more than enough whiteflies in the cotton fields after the beginning of August to transmit the virus, the later buildup and reduced numbers were probably not adequate to successfully move the virus from alternate hosts to the cotton crop early enough to initiate an epidemic in 1997 as happened 1996.

Disease management

Leaf crumple though occasionally a significant problem at specific sites or times in the western hemisphere, does not at this time warrant sustained efforts to improve management procedures. Leaf curl, by contrast, is and has been an exceptionally severe problem in Pakistan since 1991, affecting both individual growers and the nations economy adversely. The details of the epidemiology of leaf curl are not completely understood. Attempts to control the virus by applying insecticides to control the vector has failed. Public education programs encouraging better management practices have only been partially effective. In Pakistan the best chance to manage the disease in the near term seems to be continued improvement of resistant varieties developed by traditional breeding procedures at the two main cotton research institutions, CCRI and AARI.

Discussion

Concern about the possibility of the introduction of the leaf curl virus to the United States and other western hemisphere countries continues. This concern is based in part on the recent increase in the geographical range of the serious geminivirus tomato yellow leaf curl in the Dominican Republic and Cuba(Polston and Anderson 1997). The virus is believed to have been introduced on transplants from Israel. Tomato yellow leaf curl is more severe than the tomato leaf roll geminiviruses that were already present in the western hemisphere and is in some ways parallel to the cotton leaf curl, leaf crumple situation. While cotton transplants are not a likely means of introduction of cotton viruses to new areas, other susceptible host plants that would be considered as exotic or ornamental plants could serve as a plant to move the virus to new areas or continents.

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