GLOBAL ASSESSMENT OF COTTON VIRUS DISEASES

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Abstract

Virus diseases of cotton have only been of 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 minor importance. However, under changing conditions the pathogen emerges as a serious problem.

Introduction

While over 20 virus diseases of cotton have been described in the APS cotton disease compendium, only a few have actually been shown to be of virus etiology. The main ones that have been proven to actually be of virus etiology, include several gemini viruses (Brown and Nelson 1984, Mansoor et. al. 1993 and Nadeem et al. 1997), and tobacco streak virus (Cauquil and Folin, 1983).

Geminiviruses

The geminiviruses 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 gemini viruses have been sporadically important over the years. Leaf crumple, first described in the 1950's in the US, is occasionally a problem when cotton is grown as a perennial, or if is 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. It is believed to have played a 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 has an easy to apply ELISA diagnostic system, is readily transmitted in sap, in contrast to the geminiviruses and has been shown experimentally to suppress cotton plant productivity when infections occur early. The virus was widespread in the Punjab area of Pakistan in 1997. Attempts to experimentally transmit TSV by Thrips, as is the case in some otherrelated viruses, has not yet been successful.

Varietal Susceptibility

Despite the fact that cotton mosaic is still considered to be a minor problem in Pakistan, some interesting data on varietal susceptibility is 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 Pakistani 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).

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Disease Management

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

Discussion

Concern about the possibility of the introduction of leaf curl disease to the western hemisphere 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). This virus is believed to have been introduced on transplants from Israel. Tomato yellow leaf curl is more severe than many tomato leaf roll geminivirus already in the western hemisphere. In some ways, it is parallel to the cotton leaf curl, leaf crumple situation.

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