

Early Warning and Remedies for Emerging Pests in Cotton with Emphasis on Viruses

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(Presented by Akhtar Ali)

Cotton is one of the most economically important cash crops produced in the world. It provides fiber for the textile industry and also plays a pivotal role in the feed and oil industries in many countries. In addition, cotton is one of the leading cash crops in the USA and is grown in approximately twenty states (Fig. 1). To sustain the productivity of cotton for the various industries, the cultivation and maintenance of a healthy crop are essential. Unfortunately, a number of pests continuously threaten and limit the production of cotton worldwide. These include diseases caused by bacteria, fungi, nematodes and viruses. In addition, various insects' vectors and weeds also affect cotton yields. Disease is the combination of susceptible hosts, pathogens and a conducive environment, which is also known as a disease triangle. If one of the parameters of the disease triangle is not compatible with the other two, diseases cannot be produced. Therefore, it is necessary in conducive environments to use either cotton varieties that are resistant to different diseases or to eliminate reservoirs of cotton pests in order to minimize the chance of pest effects on yield.

Pests can be categorized into three possible types: invasive, evolutionary and resurgent or reemerging. Invasive pests are those that are introduced and not native to a locality. Evolutionary pests evolve over time and become resistant

to available pesticide chemicals and host plant resistance traits; while resurgent or re-emerging pests are those that are normally under control but become dominant again due to lack of chemical control or resistant cotton varieties. This paper reports on emerging cotton pests in the USA and suggests early warning indicators and remedies to minimize the devastating effects of these pests on the quality and quantity of cotton yield.

Invasive Pests

In today's world, pests have no borders and do not need any passport due to the ease of travel and transportation of commodities. In particular, seed-borne as well as a number of other pests can move from one location to another very quickly. For example, several seed-borne fungi and viruses that overwinter on alternate hosts are transmitted by a number of insect vectors. One example of invasive pests is a *Fusarium* wilt race 4 which ostensibly spread through planting seed of cotton in California before the threat was recognized (Bennett *et al.*, 2008). Extra care is necessary with seed-borne pathogens because they can reside inside the seed without any symptoms on the surface of the seed and thus are an ideal dispersal mechanism. Similarly, bacterial blight caused by *Xanthomonas citri* pv. *malvacearum* can also be

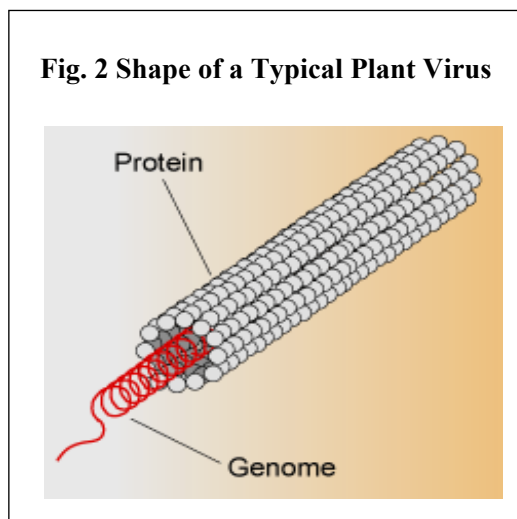
spread in cotton via planting seed (Gitaitis and Walcott, 2007). To avoid the spread of invasive pests, particularly those that are seed-borne, it is very important to select, inspect and grow planting seed in fields in such a way as to avoid even trace levels of seed-borne pathogens, to process and treat seeds with appropriate biocides and to perform germination tests before large-scale planting is done in the field. In addition, resistant cultivars are important to control the spread of infection and produce healthy seed without the hibernation of bacteria and fungal spores in the seed.

Viruses are obligate parasites composed of nucleic acids (RNA or DNA), which are surrounded by coat protein (Fig. 2) and infect almost all living organisms. More than one thousand plant viruses have been reported in the literature (King *et al.*, 2012). Approximately 20% of viruses are seed-borne, while the remaining are transmitted

Fig. 1 Cotton Growing States in the USA



through various vectors. The majority of viruses have alternate hosts and overwinter on these hosts, which include a number of weeds or unwanted host plants.



Both RNA and DNA viruses infect cotton. So far, three RNA viruses and two DNA viruses have been recognized as important pests of cotton worldwide. The three RNA viruses include cotton bunchy top virus (CBTV), cotton leaf roll dwarf virus (CLRVD) and tobacco streak mosaic virus (TSV). CBTV causes cotton bunchy top diseases in Australia, CLRVD causes cotton blue disease in Brazil and TSV has been reported in the USA and other countries. CBTV and CLRVD are transmitted by aphids, while TSV is transmitted by thrips.

Among the DNA viruses, cotton leaf curl virus (CLCuV) and cotton leaf crumple virus (CLCrV) are important and can significantly affect cotton production. CLCuV has been reported in Pakistan and India, while CLCrV has been identified in the US states of California, Arizona and Texas. Both DNA viruses that infect cotton are transmitted by whiteflies. Surveys were initiated in the cotton fields of Oklahoma and Texas during the 2013 growing season to determine the presence of virus-like diseases. A number of virus-like symptoms were observed in cotton fields. Cotton aphids were common in both Oklahoma and Texas, while whiteflies were most abundant in southern Texas. The purpose of these surveys is to determine any potential virus inoculum that infects cotton plants and might become a problem in the future.

No resistant varieties of cotton exist at this stage to combat the infection of the above-mentioned viruses. These viruses can easily be transmitted through vectors from one location to another or through virus-infected materials. Control of insect movement and virus-infected materials through quarantine checkpoints can effectively stop the spread of these viruses from one country to another and from one location to another within a country. Further research options need to be explored

to develop cotton cultivars that are resistant against these viruses in the respective countries.

Cotton Leaf Curl Virus (CLCuV) USDA-APHIS Recovery Plan

The CLCuV is a major cotton disease in India and Pakistan. Although the disease has not yet been reported in the USA, the National Plant Disease Recovery System (NPRDS) has prepared documents for plant diseases that threaten the U.S. agriculture. The purpose of these documents is to make sure that the tools, infrastructure, communication networks and capacity required to mitigate the impact of high-consequence plant disease outbreaks are such that a reasonable level of crop production is maintained in the USA. These documents are available online at <https://www.ars.usda.gov/office-of-pest-management-policy/office-of-pest-management-policy-the-national-plant-disease-recovery-system/>. Among these is a document on CLCuV prepared by Dr. Judith Brown, a well-known virologist who is professor at the University of Arizona, USA. Since virus diseases are hard to control once they are established in the field, specific recovery plans for each disease include a brief description of the ecology, the etiology of the pathogen, transmission by vectors, host range and alternative hosts, disease management in the field and how to recover the affected crop from a specific disease. Such information is a helpful tool for researchers and extension workers, as well as in the education of the many people involved in cotton production, and for making timely decisions for the control of CLCuV.

Evolutionary Pests

Two examples of evolutionary emerging pests that are currently a major impediment for cotton production in the USA are weeds and nematodes. Palmer pigweed (*Amaranthus palmeri*), which is commonly found in cotton fields throughout the season, has developed resistance to many herbicides (Heap, 2016). Possible alternatives to control pigweed could be to use rye as a cover, crop rotation, tillage, alternative herbicide modes of action, and/or strict sanitation of weeds on the borders and nearby fields to protect cotton fields from infestation.

Another important evolutionary pest is nematodes, which include various species of root-knot. During 1980, resistant cotton cultivars containing single-gene resistance against root-knot nematodes were widely adopted. Unfortunately, now the single-gene resistance may be losing efficacy in the control of root-knot nematodes. To rectify this situation, further investment is needed to develop two-gene resistant cotton varieties against root-knot nematodes.

Resurgent Pests

Some of the pests that were successfully controlled in the past are reemerging due to the use of Bt (biotech) cotton and the reduced use of insecticides. For example, Miridae, which



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is also called “plant bug,” is resurging in cotton fields in the USA. In order to control Miridae without reverting to the heavy use of insecticides, integrated pest management (IPM) practices and host resistance are required. Another example of a resurging pest is bacterial blight of cotton (also known as angular spot), which is caused by *Xanthomonas citri* pathovar *malvacearum*. Over the last twenty years, few infections of bacterial blight were reported in cotton fields until 2011. Since then, bacterial blight has been a continuous threat to cotton plants throughout the cotton-growing areas of the U.S. It is recommended that plant breeders and seed producers must avoid becoming complacent and maintain cotton cultivars resistant to bacterial blight, even though the pest was previously controlled.

Remedies to Avoid Pest Infestation

Some general methods that will help to reduce or control the infection of various pests in cotton fields include:

- Cultural practices, including crop rotation, furrow treatment and sanitation
- Resistant cultivars
- Control of insect vectors
- Application of appropriate fungicides and seed treatment

- Removal of alternate hosts of viruses
- Early detection of new or newly resistant pests.

Effective Communication

Effective communication among extension specialists, researchers, educators and farmers is the key. Both before and during the cropping season, information about the onset of a particular pest or pests, which is mostly based on the weather predictions as well as on prior occurrences, must be disseminated in a timely manner. Effective communication can be achieved by the following methods:

- Weekly/bi-weekly radio interviews
- Web-based communication
- Emails and text messages
- Field days
- Extension and research bulletins

In conclusion, it is very important to have integrated pest management in place on a county level, as well as on the state and country levels, in order to avoid threats of various pests in cotton. In addition, early warnings to growers about a particular pest are very important for them to make timely decisions before the growing season.

Acknowledgement

The Cotton Incorporated, USA, supported this work.

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