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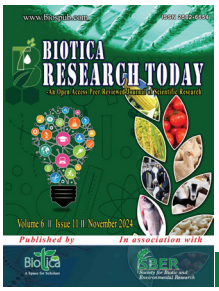

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Boll Rot Disease Complex: An Emerging Foe of Cotton in India

Licon Kumar Acharya*, Mukesh K. Khokhar, Anoop Kumar and Ajanta Birah

ICAR-National Research Centre for Integrated Pest Management, New Delhi (110 068), India

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Corresponding Author

Licon Kumar Acharya

licon.acharya@icar.gov.in

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Abstract

Cotton is the leading cash crop of the world and often referred as "white gold" due to its economic and industrial importance. India ranks first globally in terms of area and production in cotton, which is extensively cultivated across its northern, central and southern zones. Cotton faces significant biotic stresses, especially diseases. Since the commercialization of Bt-cotton, disease dynamics have changed rapidly, with diseases like boll rot, cotton necrosis and target leaf spot emerging in recent years as major threats. Boll rot, a disease complex reported to be incited by many fungal and bacterial pathogens, is drastically affecting fiber yield and/or fiber quality. This article focuses on symptomatic identification, predisposing factors responsible for the disease outbreak and integrated management strategies to check the menace which will be a great help to the farming community.

Keywords: Boll rot, Cotton, Favourable condition, Integrated management

Introduction

Cotton (*Gossypium* spp., Family: Malvaceae) is one of the most widely grown commercial crops all over the world, that acts as the source of many valuable natural textile fibres, and essential source of protein and oil in animal feed. Cotton in India is cultivated by millions of farmers and India occupies 40% of the world's area and 21% global production (Anonymous, 2023). Cotton is a long duration crop which stays in the field for nearly six months and eventually gets prone to many biotic stresses. More than sixty diseases have been reported from cotton, that reduces the yield and increases the cost of production. Introduction of *Bt* cotton and changing climatic conditions has made a major shift in disease dynamics of cotton. Recently, rotting of cotton bolls incited by various fungi, plant pathogenic bacteria and saprophytic organisms has been a common occurrence in all the cotton growing states of India. Depending on the location and epidemiological factors, more than 100 pathogens are found to be involved with the disease and hence it is more frequently called as "boll rot complex" (Sain *et al.*, 2023). Majority of these are wound pathogens causing rotting of bolls after insect bite, physical damage, or premature rupture of bolls suture, while some other are secondary contaminants.

Symptom and Causal Organisms

Based on the nature of symptoms and pathogens involved boll rot complex is broadly divided into two distinct types such as external boll rot and internal boll rot.

1. Internal Boll Rot (Bacterial Seed and Boll Rot)

The symptoms appear during flowering to boll setting stage in plant. Rotting of bolls may start from any place in the cotton plant, especially at the lower canopy.

- Bacteria enters inside the boll through mechanical injury or damage caused by sucking or piercing insects.
- The seeds, fibers and lint in locules are rotted and become light yellow to pinkish red coloured (Figure 1), though the bolls look green from outside.
- The immature diseased locule is called as a "hard lock".
- Rotten smell is observed inside the locule with a slimy presence.
- Infected bolls may or may not open.

Bacterial pathogens involved: *Pantoe aagglomerans*, *Pantoea dispersa*, *Erwinia uredovora*, *Xanthomonas citri* pv. *malvacearum*, *Bacillus pumilus*, *etc*. (Nagrale *et al.*, 2020; Ren *et al.*, 2008).

2. External Boll Rot (Fungal Boll Rot)

Symptoms are visible during boll maturity and bursting stage and usually occur on the lower to middle bolls.

- Small brown or black water-soaked dots on margins of

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Figure 1: Internal boll rot (lint staining and slimy growth)

bracts (Figure 2a) which later enlarge to cover the entire boll (Figure 2b).

• Diseased bolls are covered in white to grey, salmon-colored, or pale pinkish fungal growth (Figure 2c).

• Infection spreads to inner tissues and cause rotting of seeds. Lint becomes yellow, brown, or black colour thereby reducing the quality of seed cotton.

• The bolls fail to open and fall off from plants prematurely.

Fungi involved: *Fusarium moniliforme, F. incarnatum-equiseti* complex, *Colletotrichum gossypii*, *Lasiodiplodia theobromae*, *Aspergillus flavus*, *Rhizopus nigricans*, *Nematospora nagpuri*, *Botrydiplodisa* spp., *Alternaria macrospora*, *Phoma exigua*, *Mucor* spp., *etc*. (Nanda and Kulkarni, 2023).

Conditions Favouring Boll Rot Disease Complex

• Frequent rain and drizzle rain during flowering to boll formation stage.

• Continuous cloudy weather and reduced sunlight facilitates spread of the disease.

• High atmospheric relative humidity (RH).

• Warm and humid climate.

• Water logging condition in field.

• Stormy and higher wind speed.

• Moisture retention in bracts favours symptom development.

• Dense crop canopy with cooler microclimate.

• Infestation of sap-sucking insects (jassid, thrips) and bugs (green stink bug, red cotton bug) on buds and developing bolls predispose the pathogen infection.

Integrated Disease Management

Integrated disease management is the best approach to manage boll rot. Farmers should regularly monitor their crops and implement the following practices, to get rid of the disease and achieve optimal yields.

• Drainage of stagnated water from the fields by making channels and trenches.

• Avoid excessive use of nitrogen fertilizer.

• Optimum spacing should be maintained.

• Removal of infected bolls from the cotton fields.

• Monitor infestation of piercing and sucking insects like jassids, thrips, green stink bugs, red cotton bugs etc. during flowering and boll formation stage. Need based application of safer insecticide such as Flonicamid 50 WG @ 200 g ha^{-1} or Diafenthiauron 50 WP @ 600 g ha^{-1} or Dinotefuran 20 SG @ 150 g ha^{-1} to manage the piercing and sucking insects.

• To manage internal boll rot, destructive sampling (random collection and symptom verification in 20 bolls) and need based spray of copper oxychloride 50 WP @ 25 g per 10 liters of water during boll formation stage. The spray can be repeated within 7-15 days based on disease severity.

• On appearance of external symptoms on bolls, farmers advised to spray Carbendazim 50 WP @ 0.4 g L^{-1} or Carbendazim 12% + Mancozeb 63% WP @ 3 g L^{-1} or Propineb 70 WP @ 2.5 g L^{-1} or Propiconazole 25 EC @ 1 g L^{-1} or Metiram 55% + Pyraclostrobin 5% WG @ 2 g L^{-1} or Azoxystrobin 18.2% + Difenoconazole 11.4% SC @ 1 ml L^{-1} or Pyraclostrobin 20% SC @ 1 g L^{-1} or Fluxapyroxad 167 g L^{-1} + Pyraclostrobin 333 g L^{-1} SC @ 0.6 ml L^{-1} or Metiram 55% + Pyraclostrobin 5% WG @ 2 g L^{-1} of water.

Figure 2: External boll rot: (a) water-soaked dots on bracts; (b) brown spots on entire boll; (c) rotted bolls with mycelial growth

Conclusion

Of late, boll rot disease has become an enemy of cotton growers by causing significant loss in yield and effecting fiber quality. Continuous drizzle during flowering and boll formation stage, boll damage by piercing and sucking insects makes the bolls susceptible to disease. Involvement of many fungi and plant pathogenic bacteria in causing the disease has worsened the situation. Moreover, external symptoms are not visible in bacterial boll rot and hence regular monitoring during flowering and fruiting stage is important for taking management interventions. An integrated disease management approach involving removal of diseased bolls, drainage of stagnated water, optimum dose of nitrogenous fertilizer and need based application of pesticide will minimize the crop loss by boll rot.

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