IJASRM

International Journal of Advanced Scientific Research and Management, Volume 4 Issue 2, Feb 2019

www.ijasrm.com

ISSN 2455-6378

"A review on biological management of diseases of cotton (*Gossypium sp.)* L."

Pawan Kumar Meena[1] , Laxmi Meena[2] , Ashwani Kumar Verma[3]

[1,2,3]Department of Botany
R. R. Govt. (Autonomous) P. G. College,
Alwar, Rajasthan, India

Abstract

Cotton is an economically and commercially important crop in India and principally used over world with attention. It is also called as "The White Gold" as it tops among all the cash crops in the country and is the leading raw material for the blooming textile industries. Cotton crop suffers from a variety of fungal, bacterial and viral diseases accounting for heavy crop losses. Heavy crop losses due to diseases such as alternaria leaf spot, grey mildew, and bacterial blight have been reported. Increasing negative impact on environment due to excessive use of chemical pesticides draw the attention of researcher towards biological control of the disease. Use of disease-free seed inoculum, crop rotation, plant extracts, disease resistance varieties and fertilizer are some non-hazardous remedies to control incidence of these disease. Present review summarises significant application of biological control measures to attain a sustainable and eco-friendly management of cotton (*Gossypium spp*.) diseases.

Keywords: Eco-friendly, biological control, cotton, *Gossypium*, diseases.

1. Introduction:

The cotton plant is an important cash crop of the Malvaceae family. *Gossypium* genus consist of about fifty species but *G. arboreum L., Gossypium hirsutum L., G. barbadense L., and G. herbaceum*, are cultivated and more economically important. These four species are commercially grown for the production of lint which is used for spun into yarn (Applequist *et al.*, 2001). In the recent decade enemies of this crop like many fungal, viral, bacterial and nematode diseases have continued to ravage the cotton crop and emerged as a serious threat to its sustainable and enhanced production (Tanweer, 2013). In India also, many major and minor diseases have been reported for this crop. Out of these, major diseases caused by pathogens of fungal, bacterial and viral origin (Sekhon *et al.*, 2008). Bacterial leaf blight, boll rots, wilts and leaf spots are the most destructive cotton diseases and are also known to cause considerable losses in the yield (Chopra, 1977 and Bashi *et al.*, 1983). Different kind of strategies have been employed as remedy to control these pathogens from attacking the crop in the field.

2. Major Diseases of Cotton and Their Management

Several diseases are well recognised and their management strategies have been established in cotton.

Use of disease resistant lines/hybrids is the main strategy to manage any of these diseases. Conversely, eco-friendly measurements are also being employed successfully.

2.1 Bacterial diseases:

Bacterial blight: It is caused by *Xanthomonas campestris* pv. *malvacearum* (Smith) Dye (synonyms *Xanthomonas malvacearum* (E.F.Sm) Dowson. It has been reported from Maharashtra, Gujarat and Karnataka states of India. Among the all diseases, Bacterial blight caused by *Xanthomonas malvacearum* and boll rot complex is of major concern. This bacterium infests almost all crop stages and causes significant losses in the yield (Meshram and Raj, 1988 and Shelke *et al.*, 2012,). It is the most wide spread and devastating disease reported to cause heavy yield losses of about 10 to 30 per cent in indian states (Innes, 1983, Kalpana *et al.*, 2004 and Sandipan *et al.*, 2015). It is also reported to negatively affect the quality of lint (Sharma and Chauhan, 1985). The disease starts developing as angular leaf spots with red to brown with lesions bordered by fine veins of the leaf. These spots further progress along the major leaf veins. On progression, leaf petioles and stems also become infected and premature defoliation occurs. In severe cases it causes distortion and withering of cotyledons and death of

seedlings (Mishra and Krishna, 2001). Bacterial blight causes significant premature defoliation and in the worst cases necrosis of parenchymatous tissue in the initial phase and blockage of xylem vessels in its systemic infection. (Casson *et al*., 1977).For biological control of this disease many plant extracts as well as antagonist microorganisms have been employed. Plant extracts of *Nicotiana tabacum*, *Azaadirachta indica*, *Moringa oleifera*, *Datura alba* and *Curcuma longa* have been reported to exhibit antimicrobial effect on the pathogen (Sheoraj and Verma, 1988). Amongst the antagonist microbes, *Trichoderma hamatum* has been found significantly superior in reduction of pathogen in *in vitro* assay. Similarly, *Trichoderma harzianum* and *Psuedomonas fluorescens* are also reported to inhibit growth of *Xanthomonas* (Jagtap *et al*., 2012). F.R. Spago *et al.* (2014) reported that *Pseudomonas aeruginosa* produces secondary metabolites that have biological activity against plant pathogenic *Xanthomonas species.* Raghavendra, *et al*. (2007) soaked seeds and made three foliar sprayings of Dravya (seaweed Sargassum wightii extract) to manage bacterial blight of cotton at 10 days consecutive intervals and noticed significant results in reduction of blight incidence. It has been observed that antagonistic rhizobacteria such as *Pseudomonas fluorescens* and *Bacillus subtilis* were effective to manage colony development of the pathogen (Salaheddin *et al*., 2010). In a similar study, the endophytic *Bacillus* strains have been found to decrease incidence of this phytopathogen and increased cotton yield under greenhouse conditions (Rajendaran *et al*., 2006). Rashid and Khan (2000) reported that treatment with *Verticillium chlamydosporium* and *Paecilomyces lilacinus* is effective in controlling bacterial blight development on cotton.

2.2 Viral diseases

Cotton leaf curl: The disease characterized by leaf curling, thickening of veins, leafy enations under leaf and stunted growth (Padidam *et al*., 1995; Nawaz-ul-Rehman *et al*., 2009). The causal agent is *Cotton leaf curl virus*; a typical begomovirus which is transmitted by insect vector whitefly (*Bemisia tabaci*) (Bedford *et al*., 1994; Gilbertson *et al*., 2015). In severe cases, stunting is found in association with reduced flowering/fruiting is observed (Anonymous c, 2018). To prevent the spread of disease many biological based components along with chemical have also been employed. The best control measure is to control spread and infestation of the insect vector in fields of cotton. It was found that application of farm yard manure, composted leaves and kitchen waste promotes the ability of plants to survive against the viral attack. Similarly, the applications of organic oils (canola, sunflower and cotton seed) were observed to effectively supress the viral load in cotton plants by stopping insect vector infestation (*Bemisia tabaci* Genn.) (Humza *et al*., 2016). *Datura stramonium* has also been reported to be more effective in control of pathogen. In a study it was found that extracts of plants like *Azadirachta indica, Caleotropics procera, Eucalyptus globuls, Allium sativum, Datura stramonium, Aloe barbadensis* have antagonistic potential against *Bemisia tabaci* and cotton leaf curl virus disease under field conditions (Ali *et al*., 2010). It is also reported that *Azadirachta indica* extract, mustard oil and Salicylic acid are very effective against *Bacillus tabaci* and spread of CLCuV disease (Arif *et al*., 2004). The treatment of cotton plants with *Pseudomonas aeruginosa*, *Burkholderia cepacia* and *Bacillus spp*. has been found to reduce viral load percentage and the disease incidence. Similarly, application of microbes *Paecilomyces lilacinus*, *Verticillium chlamydosporium*, and bio-products Nimbokil 60 EC (a neem product) and Larvo BTK (a bio-insecticide) have been reported to possess antagonistic effect against this virus in cotton crop (Rashid and Khan, 2000).

Cotton streak disease: Cotton streak disease was recognized in India in past decades and identified to be caused by the *Tobacco streak virus* (TSV) (Jagtap and Dey, 2013). It is known to cause necrosis in developing cotton plants. This disease has been recognized as an emerging threat to "white gold" in India. In India, the natural hosts of TSV were sunflower and peanut and caused necrosis disease in these plants only. Transmission is also reported through mechanical means and infected seeds. (Jagtap *et al*. 2013). It has been also reported that disease can be spreaded by thrips species. In cotton, tobacco streak virus has been reported to cause a maximum of 62.7% yield loss. There is no direct biological control measures are available to control of this disease.

2.3 Fungal diseases:

Alternaria leaf spot: Causal agent of this disease is *Alternaria macrospora* Zimm.. In India, it is prevalent in Maharashtra, Gujarat, Karnataka states. Rane and Patel (1956) reported first time cotton *Alternaria* leaf spot in transitional belt. The pathogen infects all the four cultivated species of *Gossypium*. It is primarily a seed-borne disease though it can be transmitted through soil borne and air borne conidia and also by collateral hosts (Mohan *et al*., 2017). Most common symptoms of this disease are wilting of seedlings, boll spotting and lesions on primary leaves. The lesions are

circular, slightly sunken, reddish brown and finally lead to rotting (Bhattiprolu and Prasada Rao, 2009). The disease is notoriously known to account for heavy yield losses in the field (Chattannavar *et al.*, 2010). Watkins (1981) observed conidial chain on the spots. Veins of leaf get affected and spots occur on the cotyledons. In India, circular lesions develop on the bolls and leaves. The seeds may get infected and carry the infection.Though chemical control measures have been found to be very effective, biocontrol measure are also attracting researchers as they are safer and eco-friendly. As biocontrol agents bacteria *Pseudomonas fluorescens* strains and *Bacillus subtilis* and botanicals viz. *Azadirachata indica, Lantana camera*, *Calotropis procera*, *Ocimum sanctum*, *Allium cepa,* and *Allium sativum* have been reported to significantly reduce mycelial growth of the pathogenic fungus (Mohan Venkata Siva Prasad *et al*., 2017). Ramegouda (2007) also reported that garlic bulb (*Allium sativum*) extract has significant antifungal activity against *A. macrospora* under *in vitro* condition. Similar results have been observed for *Ashoka* and *Calatropis* treatment on mycelial growth of this phytopathogenic fungus. As fungal biocontrol agent *Trichoderma viride* and *Trichoderma harzianum* has been found to control growth of fungal mycelia on host plant. In the same study it was concluded that *Pseudomonas fluorescens* can be used as biocontrol agents for their bio-efficacy against Alternaria leaf spot (Gholve *et al*., 2012; Prashant *et al*., 2017). It was recorded in a study that *Trichoderma viride* exhibited highest protection of cotton from alternaria leaf spot. Chattannavar *et al.* (2004) screened 20 Bt cotton genotypes and observed eleven genotypes exhibited resistant activity to Alternaria leaf spot.

Grey mildew: The causal agent of this disease is *Ramularia areola* (Atk.). The disease appear on older leaves first as the plants reach maturity later, irregular angular, pale and translucent spots with a definite and irregular margin formed by the veins of the leaf (called areolate) are observed. The growth of the fungus mainly develops on the under layer of leaves but occasionally also on the upper surface. Gokhale and Moghe (1967b) reported that heavily infected cotyledonary leaves fall and blackish spots observed during the process of withering. It is mainly transmitted by airborne conidia (Chidambaram and Johnson, 2002). For biocontrol measures antagonist microbes have been used. In an experiment, it was concluded that *Pseudomonas fluorescens* can be used as biocontrol agents against grey mildew disease of cotton (Chattannavar, 2004; Hosagoudar, 2007; Gholve *et al*., 2012).

Root rot (*Rhizoctonia solani* Kuhn and *R. bataticola* (Taub) Butler): The root rot caused by *Rhizoctonia bataticola* (Taub) Butler and *Rhizoctonia solani* Kuhn are among most disastrous diseases of cotton. It is prevalent in the states of Punjab, Haryana, Rajasthan, western Uttar Pradesh and Jammu and Kashmir. The disease affects economically important species of cotton. Wilting of the complete plants is the first visible symptom of this disease. This wilting later on, converts into circular diseased patches and finally reddening of leaves (Monga and Sheo Raj, 2018; Raj *et al*., 1998). The antifungal potentialities of *Stenotrophomonas maltophila, Pseudomonas aeruginosa* and *Bacillus subtilis* have been also reported (Selim *et al*., 2017).

Verticillium wilt: This disease is caused by *Verticillium dahliae (*Khleb). It is more prevalent in Tamil Nadu, Karnataka. Mottling of leaves with yellowish patches, brownish necrosis of leaves, drying of leaves finally resulting in shedding of the leaves are the symptoms (Anonymous 2018a). Herbs along with microbes have been proved as an effective control measure for the disease. Hanson (2000) obtained significant results with seaweed and herbs extracts as control measure on this pathogen on cotton in greenhouse experiments. Also biological control of *V. dahliae* in cotton with a mixture of lignin and *Trichoderma viride* (Prashant *et al*., 2017) has been reported. Bioagents such as strains of *Bacillus subtilis* and *Trichoderma viridae* are also reported to be utilized as a component of Integrated Disease Management in cotton (Johnson *et al*., 2013).

Anthracnose of cotton: The anthracnose was first detected and described by Southworth (1891) from USA and causal agent was named as *Colletotrichum gossypii* (South). In India it was first reported from Bihar (Butlar, 1918) and since then has been found wide spread in Maharstra, West Bengal, Madhya Pradesh (Dastur, 1934; Ramakrishnana, 1946; Sunderaraman, 1927 and 1928). Anthracnose affect length and strength of fibre lint, lint become slightly yellow and seed from boll germinate poorly. Streptomyces strain have been reported for effective potential to control of anthracnose.

Ascochyta blight of cotton: Ascochyta blight is caused by *Ascochyta gossypii* and caused stunted growth and loss of cotton stands. Plants in early weeks (three weeks to five weeks old) are most susceptible to Ascochyta blight (Birds, 1960). Brown *et al.* (1958) reported Ascochyta blight as wet weather blight due to appearance of symptoms during prolong wet and cool weather. It infects leaves, stem and bolls of cotton, lint destroyed and discoloured grey with pycnidia in half open bolls

although flowers are not attacked (Holliday, 1980). Resistant varieties and crop rotation can minimize its incidence.

3. Conclusions: Cotton is known as an important fibre crop playing a dominant role in the economy of many countries. It suffers from a variety of diseases worldwide which affects its quality as well as economy of the dependent stake holders. As a requirement of human and environment health, application of biocotrol measures are being implemented. In cotton crop also, these management strategies have performed well with the application botanical extracts such as *Nicotiana tabacum*, *Azadirachta indica*, *Moringo oleifera*, *Datura alba*, *Curcuma longa*, *Caleotropics procera*, *Eucalyptus globuls* L., *Allium sativum* L, *Datura stramonium* L *and Aloe barbadensis*. Similarly microbes such as *Bacillus subtilis* and *Trichoderma viridae*, *Verticillium chlamydosporium*, *Paecilomyces lilacinus*, *Pseudomonas fluorescens* have been reported to effectively control cotton plant pathogens. Present study reviewed the potential bioagents and plant parts to control various disease of cotton.

References:

[1] Ali S, Khan M, Sahi S and Hassan M, Evaluation of plant extracts and salicylic acid against *Bemisia tabaci* and cotton leaf curl virus disease,Pak J Phytopathol. 22:98–100,(2010).

[2] Anonymous 2018a, Management of disease of important Agricultural crops of Tamil Nadu. http://agritech.tnau.ac.in/pdf/8.pdf

[3] Anonymous 2018c, http://www.ikisan.com/ka-cotton-disease-management.html

[4] Applequist W L, Cronn R and Wendel J F, Comparative development of fibre in wild and cultivated cotton, *Evolution & Development* 3:3-17, (2001).

[5] Arif MJ, Baig MW, Ullah S, Gogi D and Imtiaz S, Comparative efficacy of some eco-friendly substances/chemicals against cotton whitefly (*Bemisia tabaci* Genn.), Int J Agric Biol. 6:517–519, (2004).

[6] Bashi E and Sachs Y, Rotem J, *Phytoparasitica*, 11: 89-97,(1983).

[7] Bedford ID, Briddon RW, Brown JK, Rosell RC and Markham PG, Geminivirus transmission and biological characterisation of *Bemisia tabaci* (Gennadius) biotypes from different geographic regions, Ann. Appl. Biol. *125*:311–325,(1994).

[8] Bhattiprolu SL and Prasada Rao M.P. Estimation of crop losses due to Alternaria leaf spot in cotton. J. Indian Soc. Cotton Impr, 14 (2): 151-154, (2009).

[9] Casson E T, Richardson P E, Brinkerhoff L A and Gholson R K, Histopathology of immune and susceptible cotton cultivars inoculated with *Xanthomonas campestris pv. malvacearum.* Phytopathology, 67: 195- 196, (1977).

[10] Chattannavar S N, Sharamila A S, Patil S B and Khadi B M, Reaction of Bt cotton genotypes to foliar diseases, Inter. Symp. Strat. Sust. Cotton Prod. – A Global Vision 3, Crop Production, Uni. Agric. Sci., Dharwad (India): 23-25, November (2004).

[11] Chattannavar SN, Hosagoudar GN and Ashtaputre SA, Crop loss estimation due to foliar diseases in cotton, *Karnataka J. Agric. Sci*., 23: 559 – 601, (2010).

[12] Chidambaram P and Johnson I, Epidemiology of grey mildew and Alternaria blight of cotton. International Symposium on strategies for Sustainable Cotton production: 23-25,(2004) University of Agricultural Sciences, Dharwad:279-282,(2004).

[13] Chidambaram P And Johnson I, Grey mildew. In: Twenty five years achievement in cotton pathology at CICR (1976 - 2001). Published by The Director, CICR, Nagpur: 29 – 39(2002).

[14] Chopra B L, Important diseases of cotton and their control measures in India. Paper presented at staff course on cotton production, its processing and marketing technology held at P.A.U., Ludhiana, (1977).

[15] Gilbertson RL, Batuman O, Webster CG and Adkins S, Role of the insect supervectors *Bemisia tabaci* and *Frankliniella occidentalis* in the emergence and global spread of plant viruses. Annu. Rev. Virol, *2*:67–93, (2015).

[16] Gokhale V P and Moghe P G, First record of perithecial stage of *Ramularia areola* Atk. on cotton in India. Indian Phytopath, 20(2):174-175, (1967b).

[17] Hanson L E, Journal of cotton science, 4(4):224, (2000).

[18] Hanson LE, Reduction of Verticillium wilt symptoms in cotton following seed treatment with Trichoderma virens. J. Cotton Sci. 4: 224–231, (2000).

[19] Holliday P, Fungus Diseases of Tropical Crops. Cambridge University Press, U.K., 607, (1980).

[20] Hosagoudar G N, Studies on foliar diseases of cotton with special reference to Bt cotton M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad (India), (2007).

[21] Humza M, Iqbal B and Ali S, Management of Cotton Leaf Curl Virus Disease and its Vector through In Vivo Evaluation of Organic Nutritional Amendments, Organic Oils and Insecticides. J Plant Pathol Microbiol 7:387, (2016).

[22] Jagtap G P and Utpal Dey, Natural occurence of Tobacco streak virus (i lar virus) on Bt cotton hybrids. International Journal of Agricultural Sciences, 9 (1):151-153, (2013).

[23] Jagtap GP, Jangama AM and Deya U, Management of bacterial blight of cotton caused by *Xanthomonas axonopodis pv. malvacearum.* Scientific Journal of Microbiology, 1(1) :10-18, (2012).

[24] Johnson Iruthayasamy, Rajendran Ramjegathesh, Karthikeyan Muthusamy, Thiruvengadam, Raguchander & Chidambaram P, Biological control of cotton fungal foliar diseases using formulations of Trichoderma and Pseudomonas. Pestology, 37:25-28, (2013).

[25] Kalpana P, Chellamuthu V And Jeyalakshmi C, Screening of cotton hybrids against bacterial blight incited by *Xanthomonas campestris* pv. *Malvacearum* (Smith) Dye, Paper presented in Inter. Symp. Strat. Sust. Cotton Prod. – A Global Vision 3, Crop Production, 23-25 November 2004, Univ. Agric. Sci., Dharwad (India):373-374, (2004).

[26] Meshram MK and Sheo Raj, Assessing losses due to bacterial blight diseases. Plant Pathology. The Tata McGraw Hill Publ. Co. Ltd., New Delhi: 315, (1988).

[27] Mishra SP, and Krishna A, Assessment of yield potential losses due to bacterial blight of cotton. Journal of Mycology and Plant Pathology, 31: 232-233, (2001).

[28] Mohan Venkata Siva Prasad B, SL Bhattiprolu, V Prasanna Kumari and Anil Kumar P, *In Vitro* Evaluation of Bacterial Biocontrol Agents and Botanicals against Alternaria Leaf Spot Caused by *Alternaria macrospora* in Cotton. Int.J.Curr.Microbiol.App.Sci, 6(11): 750-758, (2017).

[29] Monga D and Sheo Raj, Root rot disease of cotton and its management. CICR Technical Bulletin No: 3, (2018). Http://www.cicr.org.in/pdf/rootrot_disease.pdf.

[30] Nawaz-ul-Rehman MS, Mansoor S, Briddon RW, Fauquet CM, Maintenance of an Old World betasatellite by a New World helper begomo virus and possible rapid adaptation of the betasatellite. *J. Virol., 83*: 9347–9355, (2009).

[31] Padidam M, Beachy RN and Fauquet CM Classification and identification of Gemini viruses using sequence comparisons. J. Gen. Virol, 76:249–263, (1995).

[32] Prashant B, Sandipan GR, Bhanderi RD, Patel and Solanki BG, Survey and Status of Different Diseases of Cotton under South Gujarat Region, India. Int. J. Curr. Microbiol. App. Sci. 6(9): 1362-1367, (2017).

[33] Raghavendra VB, Lokesh S and Prakash HS, Phytoparasitica, 35: 442, (2007)

[34] Rajendaran L, Saravanakumar D, Raguchander T, and Samiyappan R, Endophytic bacterial induction of defence enzymes against bacterial blight of cotton. Phytopathologia Mediterranea, *45*(3):203-214, (2006).

[35] Ramanagouda S Gaviyappanavar, Studies on grey mildew of cotton caused by *Ramularia areola* Atk. and its management. M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad (India): 88, (2012).

[36] Rane MS and Patel MK, Disease of cotton in Bombay, i.e. Alternaria leaf spot. Indian Phytopathology, 9: 106-113, (1956).

[37] Rashid Abdul and Khan Muhammad Aslam, Evaluation of antagonistic microbes and bio-insecticides against leaf curl virus and bacterial blight of cotton. Pakistan Journal of Phytopathology, 12 (2):137-141, (2000).

[38] Salaheddin K, Valluvaparidasan V, Ladhalakshmi D and Velazhahan R, Management of bacterial blight of cotton using a mixture of *Pseudomonas fluorescens* and *Bacillus subtilis*. Plant Protection Science 2010, 46(2):41-50, (2010).

[39] Sandipan B, Prashant, Desai HR and Solanki BG, Role of environmental factors on the bacterial blight (BLB) disease of cotton caused by *Xanthomonas campestris pv. malvacearum* under South Gujarat condition. Bioscan, 10 (4): 1641-1644, (2015).

[40] Sekhon P S, Singh D And Singh G, Cotton pathology research achievements and targets in Punjab. All India Coordinated Cotton Improvement Project Report. PAU, Ludhiana, (2008).

[41] Selim H M M, Gomaa N M, and Essa A M M, Application of endophytic bacteria for the biocontrol of *Rhizoctonia solani* (Cantharellales: ceratobasidiaceae) damping-off disease in cotton seedlings. Biocontrol Science and Technology, 27(1):81–95, (2017).

[42] Sharma BK, and Chauhan M S, Studies on the chemical control of foliar diseases of cotton in Haryana state. Agric. Sci. Digest, 5: 153-56, (1985).

[43] Shelke GV, Aurangabadkar L P, Kashikar A R, Wadyalkar S R, Phalak M S, Khsrkar H H And Umslkar G V, Identification of resistance source for Bacterial blight disease caused by *Xanthomonas axonopodis* pv. *Malvacearum* and its genetic inheritance in upland cotton. Cotton Research Journal, 3 (2): 167-173, (2012).

[44] Sheoraj and Verma J P, Diseases of cotton in India and their management. Review of Tropical Plant Pathology, 5: 207-254, (1988).

[45] Southworth (Miss) E, Anthracnose of cotton. Jour. Myc, 6:100-105, (1891).

[46] Spago F R, Mauro C S I, de Oliveira A G, Beranger J P O, Cely M V T, Stanganelli M M, *Pseudomonas aeruginosa* produces secondary metabolites that have biological activity against plant pathogenic *Xanthomonas* species. *Crop Prot.* 62 46–54, (2014).

[47] Sundararaman S, Administration report of the Government Mycologist. Coimbatore for 1927-28, Rep. Dept. Agrlc. Madras Presidency for the official year 1927 28: 555-572, (1928).

[48] Tanweer, Asif, Pesticides in Cotton – The Road Ahead. National convention on India cotton: Gearing up for Global leadership: 9-11, (2013).

[49] Watkins G M, Compendium of cotton diseases. American Phytopathological Society Publishers, United States of America: 28-30, (1981).