

## **Exploring Novel Sources of Resistance to Cercospora Leaf Spot and Fusarium Wilt Diseases in Cotton**

### **ABSTRACT**

Identify the sources of resistance to Cercospora leaf spot and Fusarium wilt diseases in Cotton under natural field conditions with artificial inoculation at Regional Agricultural Research Station, Warangal of the Telangana State in India. The experimental material consisted of Fifty two cotton germplasms and 13 Bt cotton hybrids with a check. They were tested against Cercospora leaf spot and Fusarium wilt diseases during Kharif \2016. Out of 52 cotton germplasms, 14 entries viz., HYPS-152, H-1250, SA-434, KH-2244N, KH-134, MRK-38, LH-2170, AKH-2822, LH-900, JK-2764, NH-615, GBHU-164, RAH-100 and HOC-5 were found resistant to Cercospora leaf spot and nine entries namely MCU-13, HYPS-152, H-1250, RAH-4, RCH-2, JK-2764, CCH1071, SCS-101, CCH-11 were found resistant to Fusarium wilt disease. Out of screened 13 Bt cotton hybrids, one entry Ankur-3224 was found resistant to Cercospora leaf spot disease and three entries namely First class, Ankur-3224 and RCH-812 were found moderately resistant to Fusarium wilt disease.

**Keywords:** Germplasms, Cotton, Resistant sources, Screening, Cercospora leaf spot disease and Fusarium wilt disease.

## 1. INTRODUCTION

“Cotton crop suffers from several diseases. The increasing pattern of leaf spots and observed Fusarium wilt disease are emerging threats to cotton cultivation. It is cultivated in about 80 countries of the world over an average area of 31.4 million hectares with 111.7 million bales (420 lb) production at rate of 775 kg lint per hectare productivity” (Prashanth *et al.* 2022). “Cercospora leaf spot and Fusarium wilt are important diseases which resulting in lower yields. Fusarium wilt (FW), caused by the fungal pathogen *Fusarium oxysporum f. sp. vasinfectum*, is a significant economic constraint to cotton production. Cercospora leaf spot of cotton was recorded in Warangal district of Telangana and Coimbatore district of Tamil Nadu with PDI varying from 1.7 to 12.7 in Bt hybrid cotton” (ICAR, AICRP on Cotton Annual Report, 2022-2023). “Fusarium cotton wilt (FW) is one of the most economically devastating cotton diseases worldwide and the threatening agent of this disease is *Fusarium oxysporum f. sp. vasinfectum* (FOV) in Pakistan” (Rizwan Asif *et al.*, 2023). “Identification of sources of resistance facilitates to evolve resistant genotypes/varieties/hybrids will be useful to the farming community in reducing the disease damage”. [19]

## 2. MATERIALS AND METHODS

### 2.1 Screening of the genotypes against the Cercospora leaf spot and Fusarium wilt diseases :

Fifty two cotton germplasms were screened with LRA 5166 susceptible check against Cercospora leaf spot and Fusarium wilt diseases under field condition in Cotton section at RARS, Warangal during Kharif 2016. Thirteen Bt cotton hybrids were screened against to Cercospora leaf spot and Fusarium wilt diseases to identify the source of resistance. Each genotype was planted in two rows of 10 meter length with a row spacing of 90 cm and the distance between plants is 60cm. The trial was laid out in RBD with two replications. Susceptible checks, LRA 5166 and RCH-929 were included after every 5 test rows for non Bt germplasms and Bt cotton respectively. Separate samples were taken for each disease from 10 tagged plants. Standard disease scale was adopted for recording the disease intensity. 1. Cercospora Leaf spot : 0-4 Scale. 2. Fusarium wilt disease : 1-5 Scale

#### Data collected:

Disease observations were noted from 10 tagged plants randomly from each entry during the crop season. Three leaves at bottom, four in the middle and three at the top of each plant thus total 10 leaves were collected from a tagged plant. Disease scored at peak intensity was observed by using

disease grades. Depending on the scores collected, per cent disease intensity (PDI) was calculated by using the formula by Wheeler 1969 as given below:

(Sum of all the numerical ratings)

$$\text{PDI} = \frac{\text{Sum of all the numerical ratings}}{\text{Total number of leaves scored} \times \text{Maximum disease grade}} \times 100$$

(Total number of leaves scored x Maximum disease grade)

**List 1: Cercospora leaf spot disease-1-5 scale**

Scale(0-4)	Cercospora leaf spot % leaf area infected	Reaction
0	Completely free from disease	Immune(I )
1	Leaf area covered up to 5%	Resistant(R )
2	Leaf area covered from 6 to 20 %	Moderately Resistant(MR )
3	Leaf area covered from 21 to 40%	Moderately Susceptible(MS )
4	Leaf area covered >40 %	Susceptible(S )

**List 2: Grading system for Fusarium wilt of Cotton**

Scale (1-5)	Fusarium wilt disease-PDI	Reaction
1	No infection	Immune (I)
2	Slight yellowing and no defoliation. Less than 5 % plants showing wilting	Resistant (R )
3	Yellowing and browning of leaves. 6- 15 % plants showing wilting	Moderately Resistant ( MR )
4	Yellowing, browning and discolouration of leaves. Some leaves fall off. late partial wilting may occur 16- 25 % plants showing wilting	Moderately Susceptible ( MS )
5.	In early infection seedlings wilt, adult plants show yellowing, browning and dropping off the leaves, finally plant wilt, above 25 % plants showing wilting	Susceptible ( S )

### 3. RESULTS AND DISCUSSION

#### 3.1 Screening of *Cercospora* leaf spot disease:

Fifty two cotton germplasms /genotypes screened against cercospora leaf spot disease revealed that 14 entries viz.,HYPS-152,H-1250,SA-434,KH-2244N,KH-134,MRK-38,LH-2170,AKH-2822,LH-900,JK-2764,NH-615,GBHU-164,RAH-100and HOC-5 were found resistant,18 entries were found moderately resistant, 16 entries were moderately susceptible and 4 entries were susceptible to *Cercospora* leaf spot disease.(Table1 a).

Among 13 Bt cotton hybrids screened against *Cercospora* leaf spot, one entry Ankur-3224 was found resistant, three entries namely First class, ACH-155 and RCH-812 were found moderately resistant, five entries were moderately susceptible and 4 entries were susceptible to *Cercospora* leaf spot disease (Table2b).

Chattannavaret *al.* 2009, “196 cotton hybrids/cultivars/genotypes were screened, Among 9 test entries, DCH 32, RAMSHH 7, GSHB 895, CCHB 2628, CCCHB 07-2, DHB 0782, NSPL 414, HAGHB 12 and Ajeet 999 were resistant to the Alternaria blight disease”.

According to Murumkaret *al.*2015, “49 genotypes with 3 checks were evaluated , He noticed that after pooled analysis of two years data of PDI, five crosses C10346B BGII XR11, C10346G BGII XR11, C10346A BGII XR11, C10026A BGII XR14 & C10346B BGII XR14 were found relatively resistant than check of Alternaria leaf spot disease for two seasons *Kharif* 2015 and *Kharif* 2016 in field”.

“Total thirty one entries with one check (LRA 5166) were screened against resistance to Alternaria leaf spot disease under rain fed condition. Thirteen entries(GSHV-159 , GBHV-170, GBHV-180, G.N.Cot-22(CC), G.N.Cot-16(LC), GSHV-173, GJHV-473, GBHV-183, GBHV-184, GBHV-187, GBHV-193, GBHV-195 and GBHV-202 were immune to Alternaria leaf spot disease in cotton” (Patel *et al.* 2016).

Prashant *et al.* 2017, “thirty nine entries including checks were evaluated for their reaction against the ALS disease. Out of 39 entries, twenty one entries were disease free, sixteen entries were resistant and two entries were moderately resistant against Alternaria leaf spot disease”.

According to Bhattiprolu *et al.* 2017 , “Ninety two Bt and five Non Bt cotton hybrids were evaluated against foliar diseases at Regional Agricultural Research Station, Guntur.Tulasi-118 BG-II

was free from cercospora leaf spot while seven hybrids viz., ABCH-1020 Bt, GK-207 Bt, RCH-368 Bt, Dhruv Bt, ACH-33-1 Bt, NCS-854 BG-II and NHH-44 Bt recorded resistant reaction; RCH-530 BG-II was resistant, 38 entries were moderately resistant to Helminthosporium leaf spot and 28 hybrids showed moderately resistant reaction to Myrothecium leaf spot”.

“Among the evaluated thirteen varieties, two varieties viz., AKH-2013-3, AKH-8828 showed resistant reaction, two varieties viz., AKH-09-5, AKH-13-0-1 recorded moderately resistant reaction to Alternaria leaf spot disease” (Bodhkeet *et al.* 2019).

Rajshaet *et al.* 2021, “on screening of 39 entries against the Alternaria leaf blight disease, twenty-one genotypes were resistant, eleven genotypes were moderately resistant during 2019 in Tamilnadu”.

Durga Prasad *et al.* 2017, “one hundred and forty three Bt cotton hybrids were evaluated, two hybrids viz., Tulasi-144 (Prachanda Bhaskar) BG-II (3.75PDI) and U5-SS-33 BG-II (4.38PDI) recorded resistant reaction while 127 hybrids were moderately resistant to Alternaria leaf spot disease during *kharif*, 2012”..

“Among 50 genotypes, thirteen entries were showed resistant reaction, 25 entries showed moderately resistance to Alternaria leaf blight in cotton” (Chaudhari *et al.* 2022).

Surveyed areas of Karnataka, Telangana, Andhra Pradesh and Tamil Nadu states, recorded Cercospora leaf spot disease PDI varied from 2.5 to 12.0 in Cotton crop (Sampath kumaret *et al.* 2023).

### **3.2 Evaluation of Fusarium wilt disease:**

Screening of 52 cotton germplasms against Fusarium wilt disease revealed that nine entries namely MCU-13, HYPS-152, H-1250, RAH-4, RCH-2, JK-2764, CCH1071, SCS-101 and CCH-11 were found resistant to Fusarium wilt disease, 9 entries were found moderately resistant, 3 entries were moderately susceptible and 31 entries were susceptible to Fusarium wilt disease (Table 2a).

Out of 13 Bt cotton, three entries namely First class, Ankur -3224 and RCH-812 were found moderately resistant to Fusarium wilt disease. (Table 2c).

Use of resistant or tolerant cultivars, can provide effective mitigation of Fusarium wilt disease management in Cotton (Soum Sanogo and Jinfa Zhang, 2016).

Asran *et al.* 2018 studied 50 of Upper Egypt genotypes and 875 families of six commercial cultivars, Five commercial cultivars Giza 90, Giza 95, Giza 86, Giza 87, and Giza 88 were very highly resistant to Fusarium wilt disease.

Two hundred sixty eight cotton genotypes were screened against verticillium wilt disease, six genotypes viz., BA119, Okra 204, H-23, Gedera-5, PI 528420 and Acala Royale were moderately tolerant to the wilt disease (Sadettin *et al.* 2019).

## CONCLUSIONS

Fourteen entries viz., HYPS-152, H-1250, SA-434, KH-2244N, KH-134, MRK-38, LH-2170, AKH-2822, LH-900, JK-2764, NH-615, GBHU-164, RAH-100 and HOC-5 were found resistant to Cercospora leafspot and nine entries namely MCU-13, HYPS-152, H-1250, RAH-4, RCH-2, JK-2764, CCH1071, SCS-101 and CCH-11 were found resistant to Fusarium wilt disease. One Bt entry Ankur-3224 was found resistant to Cercospora leaf spot disease and three entries Bt entries namely First class, Ankur -3224 and RCH-812 were found moderately resistant to Fusarium wilt disease.

## REFERENCES

1. Asran Amal A , MTM Mansour ,MS Khalil AZA, Ashour SME, Zayed Marian M, Habeb *et al.* Screening A Collection Of Cotton Genotypes For Fusarium Wilt Resistance Under Greenhouse Conditions .Egypt. J. Agric. Res. 2018; 96 (2):365-373.
2. Bhattiprolu SL, Durga Prasad NVVS, Chenga Reddy V, Bhattiprolu GR. Field evaluation of bt and non bt cotton hybrids to foliar diseases. Progressive Agriculture. 2017; 17(1).5-9pp.
3. Bodhke VS, Patil CU, Zade SB. Screening of different genotype of cotton for resistance against Alternaria leaf blight disease. International Journal of Chemical Studies. 2019; vol.7(5): 1426-1428.
4. Chattannavar SN, Hosagoudar GN, Ashtaputre SA, Ammajamma R. Evaluation of cotton genotypes for grey mildew and Alternaria blight diseases. Journal of Cotton Research and Development. 2009; Vol. 23 (1):159-162.
5. Chaudhari RJ, Kelaiya DS, Vyas UM, Parmar SK , Patel PR. Screening of different cotton varieties/genotypes against alternaria leaf blight. The Pharma Innovation Journal. 2022; 11(8): 481-484.

6. Durga Prasad NVVS, Bhattiprolu SL, Chenga Reddy V. Field evaluation of bt. Cotton hybrids against leaf hoppers and alternaria leaf spot. International Journal of Bio-resource and Stress Management. 2017; Vol 8(4): 561 – 565.
7. ICAR-AICRP (Cotton) Annual Report (2022-23). ICAR- All India Coordinated Research Project on Cotton, Coimbatore -641003, Tamil Nadu, India.
8. Murumkar PN, Ashok M, Chavan A. Comparative Studies of Alternaria Leaf Spot on CMS, GMS and Conventional ISO- Hybrids in Upland Cotton (*G. hirsutum* Linn.). International Journal of Science and Research. 2015; Volume 6(9): 1099-1103.
9. Patel RK, Prashant B, Sandipan, Patel ML, Patel AD. Screening of *Gossypium hirsutum* entries/ breeding material of cotton for resistance to different diseases under rainfed condition India. Journal of plant development sciences. 2016; Vol. 8 (11): 537-541.
10. Prashant B, Sandipan, Bhandari GR, Patel RD, Patel DM, Solanki BG. Screening of Varieties/ Breeding Materials for Resistance to Different Diseases in Natural Condition under South Gujarat Region, India. Int.J.Curr.Microbiol.App.Sci. 2017; 6(9): 1355-1361.
11. Prashanth Y, Pradeep T, Sudarshanam A, Saida Naik D, Ramprasad B. Trial Analysis for Ginning Outturn in Inter and Intra Specific Cotton Hybrids. Biological Forum – An International Journal. 2022; 14(1): 147-150.
12. Rajesha G S, Nakkeeran T, Indumathi P, Adhipathi, Chandrasekar A. Response of cotton genotypes against the incidence of alternaria leaf blight of cotton under field conditions. Journal of Environmental Biology. 2021; July, Vol. 42 :1002-1007.
13. Rizwan Asif, Saima Muzammil, Riffat Yasmin, Hammad Ahmad, Ana Ambreen. Isolation and characterization of *fusarium oxysporum* f.sp. *Vasinfestum* causative agent of cotton wilt disease in Punjab, Pakistan. Pak. J. Phytopathol. 2023. Vol. 35 (01). 103-110.
14. Sadettin Çelik, Adem Bardak, Oktay Erdoğan. Screening of upland cotton genotypes (*Gossypium hirsutum* L.) against cotton verticillium (*Verticillium dahliae* Kleb.) wilt. Bangladesh Journal of Botany. 2019; 48(4): 1185-1192.

15. Sampathkumar,Venkatesh, Kulkarni, Nidagundi and Prakash.Occurrence and Present Situation of Cercospora Leaf Spot Disease of Cotton in South Zone of India.Biological Forum – An International Journal.2023.Vol.15(4): 301-306.
16. Sheo Raj. Grading for cotton disease.Nagpur. CICR, 1988; Tech Bull.1-7pp.
17. Soum Sanogo andJinfa Zhang. Resistance sources, resistance screening techniques and disease management for Fusarium wilt in cotton.Euphytica .2016.Vol.207-255-271.
18. Wheeler BEJ.An Introduction to Plant Disease.John Willey and Sons, London, 1969; 374.
19. A. Vijaya Bhaskar. Screening of Genotypes against Cercospora Leaf Spot, Grey Mildew and Boll RotDiseases in Cotton. Biological Forum – An International Journal 14(4): 112-117(2022)



**Table 1a: Evaluation of Cotton genotypes against *Cercospora* leaf spot disease**

Sl. no.	Genotypes	Per cent leaf area incidence of <i>Cercospora</i> leaf spot disease	Scale (0-4)	Reaction
1	MCU-13	25.33	3	MS
2	HYPS-152	4.2	1	R
3	H-1250	3.7	1	R
4	SA-434	1.1	1	R
5	SA-53-1	12.5	2	MR
6	RAH-912	16.2	2	MR
7	RAS-3438	27.0	3	MS
8	RHH-101	21.0	3	MS
9	RAH-216	49.5	4	S
10	RAH-4	7.5	2	MR
11	KH-2244N	3.4	1	R
12	TCH-1020	19.0	2	MR
13	KH-134	2.9	1	R
14	TCH-1649	11.7	2	MR
15	G-CO-12	18.3	2	MR
16	NH-557	32.32	3	MS
17	JK-354	35.80	3	MS
18	IH-08	39.0	3	MS
19	ICMF-23	18.7	2	MR
20	ICMF-20	22.2	3	MS
21	PH-1008	22.7	3	MS

22	TCH-724	8.3	2	MR
23	K-3409	29.8	3	MS
24	NA-640	16.6	2	MR
<b>Sl. no.</b>	<b>Genotypes</b>	<b>Per cent leaf area incidence of Cercospora leaf spot disease</b>	<b>Scale (0-4)</b>	<b>Reaction</b>
25	BS-37	23.0	3	MS
26	RCH-2	23.33	3	MS
27	JK-205	10	2	MR
28	CNK-1094	11.3	2	MR
29	CSH-3118	9.3	2	MR
30	MRK-38	3.2	1	R
31	BRS-23	6.0	2	MR
32	BWR-44	15.7	2	MR
33	F-2089	27.0	3	MS
34	LH-2170	4.0	1	R
35	L-389	21.32	3	MS
36	AKH-2822	2.9	1	R
37	LH-900	4.0	1	R
38	SA-1004	13.0	2	MR
39	ARB-8901	34.32	3	MS
40	GBHB-170	36.0	3	MS
41	BB-2	70.3	4	S
42	G-COT-10	40.0	3	MS
43	JK-2764	3.7	1	R
44	NH-615	4.0	1	R
45	D-6	14.08	2	MR
46	CCH1071	8.0	2	MR

47	SCS-101	54.7	4	S
48	GBHU-164	3.1	1	R
49	CCH-11	8.0	2	MR
<b>Sl. no.</b>	<b>Genotypes</b>	<b>Per cent leaf area incidence of Cercospora leaf spot disease</b>	<b>Scale (0-4)</b>	<b>Reaction</b>
50	RAH-100	5.3	1	R
51	HOC-5	5.3	1	R
52	LRA-5166 (SC)	58	4	S

[R-Resistant, MR-Moderately Resistant, S-Susceptible, MS-Moderately Susceptible]

**Table 2a: Evaluation of Bt Cotton genotypes against Fusarium wilt disease**

Sl.no.	Genotypes	Fusarium wilt disease(PDI)	Scale(1-5)	Reaction
1	MCU-13	4.3	2	R
2	HYPS-152	2.4	2	R
3	H-1250	5.2	2	R
4	SA-434	32.0	5	S
5	SA-53-1	7.6	3	MR
6	RAH-912	56.34	5	S
7	RAS-3438	64.64	5	S
8	RHH-101	37.3	5	S
9	RAH-216	8.0	3	MR
10	RAH-4	2.3	2	R
11	KH-2244N	45.32	5	S
12	TCH-1020	34.42	5	S
13	KH-134	75	5	S
14	TCH-1649	33.33	5	S
15	G-CO-12	38.36	5	S
16	NH-557	63.32	5	S
17	JK-354	35.63	5	S
18	IH-08	43.22	5	S
19	ICMF-23	80.64	5	S
20	ICMF-20	42.34	5	S
21	PH-1008	84.26	5	S

22	TCH-724	43.34	5	S
23	K-3409	10	3	MR
24	NA-640	35.23	5	S
<b>Sl.no.</b>	<b>Genotypes</b>	<b>Fusarium wilt disease(PDI)</b>	<b>Scale(1-5)</b>	<b>Reaction</b>
25	BS-37	44.68	5	S
26	RCH-2	1.0	2	R
27	JK-205	20.0	4	MS
28	CNK-1094	64.32	5	S
29	CSH-3118	15.20	3	MR
30	MRK-38	23.34	4	MS
31	BRS-23	27.54	5	S
32	BWR-44	28.66	5	S
33	F-2089	29.12	5	S
34	LH-2170	36.34	5	S
35	L-389	65.43	5	S
36	AKH-2822	19.90	4	MS
37	LH-900	54.23	5	S
38	SA-1004	33.33	5	S
39	ARB-8901	32.84	5	S
40	GBHB-170	36.26	5	S
41	BB-2	48.22	5	S
42	G-COT-10	39.32	5	S
43	JK-2764	5.7	2	R
44	NH-615	6.0	3	MR
45	D-6	8.7	3	MR
46	CCH1071	3.2	2	R
47	SCS-101	2.6	2	R

48	GBHU-164	8.9	3	MR
49	CCH-11	2.6	2	R
50	RAH-100	10	3	MR
<b>Sl.no.</b>	<b>Genotypes</b>	<b>Fusarium wilt disease(PDI)</b>	<b>Scale(1-5)</b>	<b>Reaction</b>
51	HOC-5	9.3	3	MR
52	LRA-5166 (SC)	88.56	5	S

[R-Resistant, MR-Moderately Resistant, MS-Moderately Susceptible, S-Susceptible]

**Table 2b: Evaluation of Bt Cotton hybrids against Cercospora leaf spot disease**

Sl. no.	Hybrids	Per cent leaf area incidence of Cercospora leaf spot disease	Scale (0-4)	Reaction
1	Bhakti	45.2	4	S
2	Balhwan	52	4	S
3	Raja	56.4	4	S
4	Akka	25.4	3	MS
5	Khushi	28.0	3	MS
6	Ankur -3224	5.2	1	R
7	First class	8.4	2	MR
8	ACH-155	15.6	2	MR
9	ACH-199	26.4	3	MS
10	RCH-836	30.8	3	MS
11	RCH-812	6.8	1	R
12	ATM	32.5	3	MS
13	RCH 929(SC)	50	4	S

[R-Resistant, MR-Moderately Resistant, MS-Moderately Susceptible, S-Susceptible]

**Table 2c: Evaluation of Bt Cotton hybrids against Fusarium wilt disease**

Sl. no.	Hybrids	Fusarium wilt (PDI)	Scale (1-5)	Reaction
1	Bhakti	19.8	4	MS
2	Balhwan	22.4	4	MS
3	Raja	25.4	5	S
4	Akka	28.2	5	S
5	Khushi	23.4	4	MS
6	Ankur -3224	14.2	3	MR
7	First class	12.4	3	MR
8	ACH-155	17.6	4	MS
9	ACH-199	27.2	5	S
10	RCH-836	28.4	5	S
11	RCH-812	12.8	3	MR
12	ATM	22.5	4	MS
13	RCH 929(SC)	50	5	S

[R-Resistant, MR-Moderately Resistant, MS-Moderately Susceptible, S-Susceptible]