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Evaluation of Cotton Germplasm for Source of Resistance Against Cotton Leaf Curl Disease

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Cotton leaf curl disease (CLCuD) is main constraint to American cotton (*Gossypium hirsutum*) cultivation which is one of the most important cash crops in northwestern India. At this time no single variety/hybrids have available that's having resistant reaction towards cotton leaf curl disease. Screening of germplasms is a basic step to explore resistant source. With this objective, the germplasm comprising three hundred seventy seven genotypes were evaluated against cotton leaf curl disease at CCS HAU Cotton Research Station, Sirsa during *kharif* 2013 to 2015. None was found immune/ disease free or highly resistant. However, thirty four genotypes were found resistant, one hundred thirty four expressed moderately resistant reaction and one hundred forty four were found moderately susceptible. Forty nine genotypes were observed susceptible and sixteen were found highly susceptible to CLCuD. The resistant genotypes may be used for variety/ hybrid development or as a donor of resistant genes.

Keywords: Cotton leaf curl disease, Germplasm, *Gossypium hirsutum*, Resistance.

Cotton is an important commercial cash crop of global importance. India occupies largest area in the world (12.6 million ha.). However, India ranked second in production (37.4 million bales) with a very low productivity of 537 kg/ha as compared to world average of 760 kg/ha[4]. Among the many limiting factors of low productivity, cotton leaf curl disease (CLCuD) is most crucial in northwestern India. The appearance of the disease at seedling stage seriously retards the flowering, boll formation and seed cotton yield.

Among the recommended practices to control cotton leaf curl disease (CLCuD), cultivation of resistant cultivars and management of causal agent are the most promising. Development of resistant varieties along with agronomic, fertilizer, insecticidal control and biotechnological methods can be used alone and in combination to control this severe disease[5]. Among these, development of cotton leaf curl resistant varieties is long-term approach to cope with this problem and to save this crop from the ravages of CLCuV. Resistance breaking cotton leaf curl Burevala virus (CLCuBuV) is now the dominant virus strain in many fields of northwestern India[9]. Thus the main objective of present study was to find out resistant genotypes, possessing desirable characteristics that can directly be used for commercial cultivation, or it can be used in hybridization programme for the development new resistant cultivars.

MATERIALS AND METHODS

The present investigation of evaluation of cotton gemplasm for source of resistance against cotton leaf curl disease (CLCuD) was carried out to identify the sources of resistance under field condition. The germplasm comprising three hundred seventy seven genotypes were sown in

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two replications with plant to plant and row to row spacing of 30 cm and 67.5cm, respectively during *kharif* 2013 to 2015at CCS HAU Cotton Research Station Sirsa under natural field condition where virus source and vector were abundantly present. Recommended agronomical practices were carried out to raise good crop. CLCuD Susceptible check HS 6 was sown after every fourth row and also as border of two rows around the experiment to ensure the enough inoculum. All the plants of a genotype were thoroughly observed for appearance of cotton leaf curl virus symptoms and observation on the disease intensity was recorded according to revised rating scale describe by AICCIP (Table 01).

Calculation of PDI

Per cent disease Intensity (PDI) was calculated for each entry by using the following formula given below:

$$PDI = \frac{\text{Sum of all the numerical ratings of plants observed}}{\text{Total no. of plants observed x Maximum grade}} \times 100$$

RESULTS AND DISCUSSION

The average of three years percent diseases intensity (PDI) was calculated for genotypes of germplasm collection at CRS, Sirsa (Table 02). Average Per cent diseases intensity ranged from 11.1 to 57.2 among all the genotypes. The result of pooled data over the years of three hundred seventy seven genotypes evaluated, none was found immune/diseases free and/or highly resistant However, thirty four genotypes were recorded as resistant; one hundred thirty four expressed as moderately resistant reaction, while one hundred forty four were found moderately susceptible. Further, forty nine were observed susceptible and sixteen were found highly susceptible to cotton leaf curl disease (Table 03).

Screening of germplasm to explore resistant source is a basic step towards the solution of this hazardous problem. With this objective genetic material were graded for degree of tolerance to the cotton leaf curl virus after screening on a natural hot spot by various workers. Ahuja *et al.* (2007) screened one hundred and forty two cotton germplasm lines for cotton leaf curl virus symptoms in field evaluation during 2003 to 2005 and observed dominant expression of the disease resistance and there were no maternal or cytoplasmic effects detected from reciprocal hybridization. As the same way 1799 cotton germplasm lines evaluated against CLCuD during 1997-2006 under natural conditions and only seven lines were recorded resistant to cotton leaf curl virus disease[7]. *G. stockii* is a resistant species to

Table 1. Rating scale of PDI given by AICCIP

Symptoms	Disease Severity (grade)	Per cent Disease intensity	Disease reaction
Complete absence of symptoms	0	0	Immune /disease free
Thickening of few small scattered veins on one or few leaves of a plant observed after careful observation	1	0.1-10	Highly Resistant
Thickening of small group of veins, no leaf curling, no reduction in leaf size and boll setting	2	10.1-20	Resistant
Thickening of all veins, minor leaf curling, leaf enations, deformity of internodes with minor reduction in leaf size but no reduction in boll setting.	3	20.1-30	Moderately Resistant
Severe vein thickening, moderate leaf curling, leafy enations, minor deformity of internodes and minor reduction in leaf size and boll setting.	4	30.1-40	Moderately Susceptible
Severe vein thickening, moderate leaf curling, leaf enations and deformity of internodes with moderate reduction in leaf size and boll setting followed by moderate stunting.	5	40.1-50	Susceptible
Severe vein thickening, leaf curling, reduction in leaf size, leafy enations, deformed internodes and severe stunting of plant with no or few boll setting	6	> 50	Highly Susceptible

Table 2. Reaction of Cotton Leaf Curl Disease on genotypes of American Cotton

S. No.	Name of Genetic Collection	PDI (Percent Disease Intensity) 2013	2014	2015	Average
1	101-102B	16.2	14.4	24.2	18.3
2	101-102-B 2	22.4	26.6	30.0	26.3
3	1412-A 1	28.3	25.5	34.2	29.3
4	150-3-1-1	35.4	44.4	41.7	40.5
5	1556F	20.6	14.4	27.2	20.7
6	1695-175 J	20.2	20.2	26.7	22.4
7	16-SH-1274	34.2	22.2	40.0	32.1
8	320-F	52.4	51.5	51.9	51.9
9	33-STONE VILLE 213	46.2	40.2	55.0	47.1
10	36B	26.6	25.6	30.0	27.4
11	42- STONE VILLE 62	20.5	12.2	27.4	20.0
12	43-P 12	41.6	40.2	45.0	42.3
13	49-CSH 875	32.6	32.2	40.7	35.2
14	4-SAMARU 26	18.2	21.1	32.8	24.0
15	59-SV-7A	45.2	42.2	43.3	43.6
16	7203-14-104	8.5	11.1	19.7	13.1
17	76-IH 23	29.6	30.4	33.3	31.1
18	78-CAT 131	50.6	56.6	51.7	53.0
19	9-1487	20.4	25.5	31.7	25.9
20	9-3X13L1 CO2-1-3	16.6	10.0	29.6	18.7
21	98-NH-BBR 44	32.2	31.1	44.2	35.8
22	A 02 N 89	18.6	22.2	30.7	23.8
23	A 02N 65	18.4	22.2	26.7	22.4
24	A 03 N 121	35.4	33.3	36.7	35.1
25	A 03 N 153	18.9	31.1	33.7	27.9
26	A 03 N124	28.3	31.1	40.0	33.1
27	A O2N 40	48.1	31.7	35.2	38.3
28	A O2N 75	30.3	31.7	41.7	34.5
29	A02 N 149	36.4	33.3	40.0	36.6
30	A02 N 106	30.6	30.6	38.3	33.2
31	A02 N 52	26.6	28.6	33.3	29.5
32	A02 N 84	33.0	33.3	43.3	36.5
33	A02N 85	56.2	50.0	50.0	52.1
34	A03 N 139	24.9	20.2	26.1	23.7
35	A03 N 144	26.8	29.1	38.3	31.4
36	A03 N 148	30.2	31.1	36.7	32.7
37	A03 N 150	19.9	22.2	26.3	22.8
38	A03 N132	46.5	43.3	55.6	48.5
39	A-72-62	23.2	23.3	33.4	26.7
40	ABH 6	33.2	18.8	38.3	30.1
41	ABOHAR 3	23.2	29.6	33.3	28.7
42	ACOLA SJ-1	16.6	23.3	38.3	26.1
43	AET 55	48.1	33.3	45.0	42.1
44	AK-182/Gland 361-3462	20.6	31.7	46.7	33.0
45	AKG -2/54	25.6	34.4	31.7	30.6
46	AKG 2	40.5	38.6	46.7	41.9
47	AKG-3/62	20.5	31.7	35.6	29.3
48	AKH 2910	24.6	10.6	30.0	21.7
49	AKH 9913	33.6	22.2	37.6	31.1
50	AKH 8931	27.5	29.3	32.1	29.6
51	ALBAR 629	42.1	43.3	40.0	41.8
52	ALBAR-7-MB	15.4	22.2	26.3	21.3
53	AMBASSADOR	28.4	26.6	32.4	29.1
54	AMERICANN-ECTARILESS	30.2	30.2	31.1	30.5
55	ANMOL	50.0	51.6	53.3	51.6
56	AO3 N103	51.6	50.0	51.7	51.1
57	AO3 N146	25.6	30.2	38.3	31.4
58	ARB 757	35.0	33.8	38.3	35.7
59	ARKANSAS GREEN	20.6	25.5	36.7	27.6
60	ATHENS I	26.4	33.3	45.6	35.1
61	AUBURN	25.8	33.3	42.4	33.8
62	AV 3649	25.6	29.8	36.7	30.7
63	AVB NE 165	30.5	33.3	35.0	32.9
64	AVB SM 213	50.2	52.2	51.7	51.4
65	AVB SM 277	16.4	20.0	30.6	22.3
66	B 143	16.8	19.3	28.9	21.7
67	B 56-181	18.5	28.8	34.4	27.2
68	B 57-876	32.4	33.3	35.3	33.7
69	B 68-1146	32.4	30.0	30.8	31.1
70	B 72-2889	32.6	42.2	41.5	38.8
71	BADNAWARI	18.6	21.7	25.0	21.8
72	BAN 9561	24.4	24.4	26.7	25.2
73	BATIN ROUGH	26.4	29.1	32.7	29.4
74	BC 68-2	36.8	40.8	47.7	41.8
75	BHAGYA	36.4	40.0	43.3	39.9
76	BHATINDA No. 1	46.2	44.4	38.3	43.0
77	BJR 592	27.6	30.8	48.3	35.6
78	BJR-JK 97-16-4	30.6	36.6	41.7	36.3
79	BLIGHT MASTER	15.2	15.5	21.7	17.5
80	BM COT 95-BLL	10.2	12.2	25.2	15.9
81	BN FREGO-BRACT	20.6	24.4	28.9	24.6
82	BR01-200/85	29.5	31.7	33.3	31.5
83	BS 101	20.3	23.3	28.3	24.0
84	BURI O349 (1075)	20.8	28.8	39.3	29.6
85	BURI	19.6	29.9	28.9	26.1

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86	BWR 28	29.4	31.8	35.7	32.3
87	BWR 38562	20.6	23.3	37.0	27.0
88	C 100A	25.4	20.6	30.0	25.3
89	C 1412-A	44.4	41.2	46.7	44.1
90	CA 99541	46.2	43.6	48.3	46.0
91	CAK PH-93	32.4	31.1	35.2	32.9
92	CCH 510-4	30.2	31.6	38.3	33.4
93	CIRPAN 2362	15.6	22.4	26.7	21.6
94	CNH 120	32.0	30.8	33.3	32.0
95	CNH 13	32.4	31.4	39.6	34.5
96	CNH 151	30.4	29.3	32.6	30.8
97	CNH 154	31.6	31.1	40.0	34.2
98	CNH-36	48.2	45.5	48.1	47.3
99	COKER 310	46.2	41.8	53.7	47.2
100	COKER 413	30.5	35.5	43.6	36.5
101	COKER 100	20.2	26.6	33.3	26.7
102	COKER 210	30.6	21.1	31.7	27.8
103	COTTON 14	46.4	41.1	51.7	46.4
104	COTTON 35	19.8	21.1	25.2	22.0
105	COTTON 4	36.3	32.2	38.3	35.6
106	COTTON 5	20.8	22.1	30.2	24.4
107	CPD 03-2	20.8	24.4	31.1	25.4
108	CPD 8-1	45.7	46.6	45.0	45.8
109	CSH 36	15.6	29.2	35.4	26.7
110	CSH 3050	14.8	29.3	30.6	24.9
111	CSH 911	10.2	10.2	23.6	14.7
112	CVT 5	9.6	19.3	26.7	18.5
113	CVT 6	16.4	21.7	28.1	22.1
114	DC 1-20	30.4	33.5	48.3	37.4
115	DC I-116	32.4	35.5	46.7	38.2
116	DELCERO	20.1	10.6	20.4	17.0
117	DELCOT377	22.2	21.8	31.7	25.2
118	DELFOS	26.4	19.3	30.0	25.2
119	DELTA SL	10.7	13.3	21.7	15.2
120	DELTAPINE (C5)	28.4	32.3	43.3	34.7
121	DH 21	30.2	29.1	28.3	29.2
122	DHLYY	16.8	14.4	25.8	19.0
123	DHY 286	52.1	56.6	54.2	54.3
124	DP 16	30.3	34.4	53.9	39.5
125	DSU 28	20.4	22.2	36.7	26.4
126	DUNN	28.2	28.8	31.4	29.5
127	DUNN 56-C-B	36.4	33.3	46.7	38.8
128	EC 141679	20.6	22.2	23.3	22.0
129	EC 141712	30.5	31.1	30.0	30.5
130	EC 76765	40.9	51.1	36.7	42.9
131	EC124096	20.0	35.5	45.0	33.5
132	EC132033	26.3	25.5	35.8	29.2
133	EC 356587	26.2	33.3	33.3	30.9
134	EC 52-SN	28.4	38.5	36.7	34.5
135	EMPIRE 61	34.5	44.3	41.7	40.2
136	EPRT 6	20.6	22.4	35.0	26.0
137	F 1980	20.6	19.8	23.8	21.4
138	F 1378	24.6	26.6	28.3	26.5
139	F 1794	33.4	32.4	48.3	38.0
140	F 1861	20.6	20.4	25.0	22.0
141	F 1875	24.6	33.3	26.7	28.2
142	F 1914	40.5	39.6	45.0	41.7
143	F 1980	30.6	20.1	38.3	29.7
144	F 2035	25.4	29.6	36.7	30.6
145	F 414	20.6	21.7	26.3	22.9
146	F 846	50.0	54.4	41.7	48.7
147	FD 89	35.4	40.0	46.7	40.7
148	FFS103	36.4	33.3	38.3	36.0
149	FM 531 B LINE-7	29.0	29.1	30.0	29.4
150	FREGOBRACT	32.4	36.6	37.9	35.6
151	FS 128	40.6	31.6	41.7	38.0
152	G COT 8- F	45.2	53.4	51.7	50.1
153	G COT100	37.4	40.0	41.7	39.7
154	G COT12	20.2	13.3	26.7	20.1
155	G COT8M	20.6	27.7	22.6	23.6
156	G17	30.4	22.6	30.0	27.7
157	G205- SA	34.5	35.5	36.7	35.6
158	G245-10-2	35.2	30.2	40.0	35.1
159	G67	40.5	20.3	43.7	34.8
160	GANGA	33.4	32.2	35.2	33.6
161	GANGA NAGER AGETI	30.2	29.3	36.7	32.1
162	GBHV 148	36.4	22.2	30.0	29.5
163	GICS15	28.6	29.8	33.7	30.7
164	GISV12	24.5	29.3	28.3	27.4
165	GISV86/58	36.4	34.4	33.3	34.7
166	GJHS16	30.5	29.4	31.7	30.5
167	GJHS270	30.6	33.3	30.0	31.3
168	GJHS53	20.8	21.1	23.3	21.7
169	GL-CO2-4 -4	30.9	33.3	44.4	36.2
170	GN67-1 DWARF	30.4	26.6	26.7	27.9
171	G-OKRA	30.1	39.5	31.7	33.8
172	GREGG35	29.6	30.0	36.3	32.0
173	GREGG45	24.7	22.2	25.8	24.2
174	GRS6015	49.7	50.2	40.0	46.6
175	GRS60-GIL3-4	20.4	16.6	28.3	21.8
176	GS10	34.9	30.1	45.0	36.7
177	GS10N	24.6	31.7	32.5	29.6
178	GS23	21.6	33.3	35.0	30.0
179	GTSV-337	45.6	43.3	45.6	44.8
180	GUMBO	30.2	31.1	31.7	31.0
181	H 655 C	18.4	20.0	25.0	21.1
182	H103	16.3	19.3	21.7	19.1
183	H1117	10.1	11.1	18.3	13.2

184	H1150	46.2	41.1	41.7	43.0	234	LH 2001	32.8	40.0	51.2	41.3
185	H1180	19.7	23.3	28.3	23.8	235	LH1802	25.6	23.7	31.7	27.0
186	H1226	32.9	30.1	28.3	30.4	236	LH1911	24.6	24.4	38.3	29.1
187	H1236	33.0	33.3	31.6	32.6	237	LH1953	28.0	20.6	35.0	27.9
188	H14	15.9	18.3	21.6	18.6	238	LH1960	19.8	28.8	27.8	25.5
189	H655C	20.6	26.6	25.6	24.3	239	LH1995	20.4	22.2	34.4	25.7
190	H974	23.4	33.3	33.7	30.1	240	LH2002	46.7	40.0	55.0	47.2
191	HS 251	50.0	43.3	53.3	48.9	241	LOCKET-4487	50.1	53.3	55.2	52.9
192	HS100	22.1	21.1	38.3	27.2	242	LOCKET4789	46.7	42.7	52.4	47.3
193	HS182	33.6	33.3	40.0	35.6	243	LRK516	29.8	21.8	41.7	31.1
194	HS2	45.6	50.4	45.0	47.0	244	LSS	26.4	19.1	42.9	29.5
195	HS6	51.9	58.8	58.3	56.3	245	LSV24	26.4	33.3	40.0	33.2
196	I -81	20.3	21.6	27.0	23.0	246	LUXMI	10.2	14.4	16.7	13.8
197	IAN1327 F	27.7	29.1	36.7	31.2	247	M11	20.1	35.5	34.8	30.1
198	IC1832	38.0	36.6	37.0	37.2	248	M8	20.8	35.5	31.1	29.1
199	IRMA323	28.4	33.3	37.9	33.2	249	MAHALUXMI	16.4	20.4	13.3	16.7
200	JK 344	20.6	22.2	23.3	22.0	250	MC130	10.1	11.1	16.7	12.6
201	JK105	20.6	31.7	30.0	27.4	251	MC82	8.4	10.7	20.0	13.0
202	JK255	41.6	40.4	33.3	38.4	252	MC86	10.8	22.2	23.3	18.8
203	JK345	35.4	30.2	36.7	34.1	253	MCU7	12.6	22.2	22.9	19.2
204	JK97-621	34.2	31.5	33.3	33.0	254	MDU5	25.4	28.8	35.0	29.7
205	JK97-MB	26.3	23.3	35.0	28.2	255	MESR17	25.4	29.8	36.7	30.6
206	JKCL702	46.7	40.2	46.7	44.5	256	MZ561-3	30.2	30.3	34.7	31.7
207	JP No.9	40.0	39.6	47.9	42.5	257	N3	20.6	24.4	30.0	25.0
208	JP17	29.4	39.6	45.0	38.0	258	N34	25.9	30.2	31.7	29.3
209	JP-No-8	56.8	56.6	58.3	57.2	259	N72	42.5	40.4	40.5	41.1
210	K 4005	24.6	33.3	33.3	30.4	260	N86	30.8	30.0	35.0	31.9
211	KDGH178	52.2	50.0	56.7	53.0	261	NA 1375	30.7	30.5	45.2	35.5
212	KDGH50	12.4	12.2	18.2	14.3	262	NA920	45.7	30.4	53.3	43.1
213	KDGH50-4	30.6	22.2	32.5	28.4	263	NCAC11	35.2	35.3	44.4	38.3
214	KH 155	25.4	29.3	25.6	26.8	264	NCAC15	17.7	22.2	31.7	23.9
215	KH113	30.8	31.6	30.0	30.8	265	NHBBR-38	28.7	32.2	26.7	29.2
216	KH138	15.4	22.2	28.9	22.2	266	NM 755404	26.4	20.2	36.7	27.8
217	KHD2	16.8	24.4	28.9	23.4	267	OKRA RED FREGO	38.4	31.8	48.3	39.5
218	KKS	29.1	33.3	30.2	30.9	268	P 367	9.5	12.2	30.0	17.2
219	KKS4F	20.3	21.1	24.4	21.9	269	P 729-37	12.4	11.1	15.7	13.1
220	L 759	20.9	16.6	21.7	19.7	270	P15	26.6	20.8	26.7	24.7
221	L11	35.2	34.4	40.0	36.5	271	P216-F	8.4	12.2	23.3	14.6
222	L147	32.1	33.3	34.6	33.3	272	PARAS	36.4	31.1	38.1	35.2
223	L604	27.6	29.3	21.7	26.2	273	PAYMASTERIII	28.6	31.1	45.1	34.9
224	L740-1	20.4	23.3	25.0	22.9	274	PB-557	29.4	31.1	38.0	32.8
225	L762	37.2	35.5	40.0	37.6	275	PB84-RV 4	36.2	39.5	48.3	41.3
226	LA FRGO BRACT	19.2	27.7	23.3	23.4	276	PD380	37.8	33.3	53.3	41.5
227	LAM GUNTURE	46.7	42.6	53.3	47.5	277	PH-348	26.6	23.3	25.0	25.0
228	LAM787	34.2	33.3	41.7	36.4	278	PIL-60	26.4	33.3	43.3	34.3
229	LANKBURN	36.0	33.3	38.3	35.9	279	PIL104	9.6	11.1	30.0	16.9
230	LAS 45 RED AK	27.4	26.6	30.0	28.0	280	PIL18	24.3	28.8	33.7	28.9
231	LASSANI 11	25.6	30.0	33.3	29.6	281	PIL20	24.8	33.3	43.3	33.8
232	LCH10	50.0	51.1	56.7	52.6	282	PIL27	20.6	19.3	25.6	21.8
233	LCMS6B	36.4	28.8	40.0	35.1	283	PIL8	9.9	10.4	17.0	12.4

284	PIL8-5	25.4	30.2	40.0	31.9
285	PIL8-7	12.2	15.5	18.3	15.3
286	PIL9	21.5	31.1	40.0	30.9
287	PK54	21.6	33.6	35.0	30.1
288	PKV0804	22.1	22.2	35.4	26.6
289	PKV081	16.6	26.6	30.0	24.4
290	PKY RAJAT	29.5	31.8	37.5	32.9
291	PRS72	19.7	26.6	28.3	24.9
292	PUSA 1803	26.4	32.5	39.6	32.8
293	PUSA 3216	13.9	23.3	38.3	25.2
294	PUSA 95	13.2	21.1	28.9	21.1
295	PUSA180	29.4	30.4	32.4	30.7
296	PUSA31	19.4	20.2	38.8	26.1
297	PUSA317	47.5	51.5	56.7	51.9
298	PUSA864	25.6	28.3	33.3	29.1
299	R-40	32.4	41.1	55.0	42.8
300	RAH 3	26.6	24.4	31.7	27.6
301	RAH53	26.4	28.6	33.3	29.4
302	RCMS2B	20.3	19.4	26.7	22.1
303	REBA B50	32.5	52.8	40.5	41.9
304	REBA PVT9	6.4	10.1	16.7	11.1
305	RED	21.2	23.3	35.0	26.5
306	REX66	25.3	33.3	44.2	34.3
307	RH1	26.7	29.8	46.7	34.4
308	RHC1179	22.2	31.1	46.7	33.3
309	RHC2022	35.4	40.0	58.3	44.6
310	RHC9740	20.2	17.7	25.6	21.2
311	RS2098	30.5	40.0	42.8	37.8
312	RS 2351	25.4	14.4	48.3	29.4
313	RS 2390	30.6	20.4	40.7	30.6
314	RS2013	28.4	18.8	30.0	25.7
315	RS2097	24.5	20.6	26.7	23.9
316	RS810	30.4	29.1	36.1	31.9
317	RS875	30.6	35.6	35.2	33.8
318	RS89	30.5	21.1	41.7	31.1
319	RST9	24.6	44.4	40.0	36.3
320	RUU/U	31.6	35.8	37.0	34.8
321	S44	18.2	22.2	25.0	21.8
322	S4727	18.9	22.2	30.0	23.7
323	S 69-993	32.5	30.8	38.3	33.9
324	S344	28.4	28.8	38.1	31.8
325	SA 966	42.6	42.8	50.0	45.1
326	SA1197	35.2	45.8	51.7	44.2
327	SA1243	30.2	40.0	53.3	41.2
328	SA1246	32.4	31.6	51.7	38.6
329	SA201	36.4	20.5	42.9	33.3
330	SA305A	10.6	21.1	43.8	25.2
331	SA497	12.8	16.6	35.0	21.5
332	SA72	29.4	23.2	34.8	29.1
333	SA7A	20.6	18.3	53.3	30.7
334	SAHANE	23.7	29.1	35.2	29.3
335	SCS52-3	23.4	23.3	31.7	26.1
336	SHARDA	20.4	16.6	34.4	23.8
337	SIMA1	18.9	26.6	36.7	27.4
338	SIN8	30.5	31.6	40.0	34.0
339	SK663	20.7	23.3	36.7	26.9
340	SLM8	15.6	14.4	28.3	19.4
341	SP84-213	32.0	32.7	43.7	36.1
342	SR38	10.8	12.2	32.7	18.6
343	SR5	25.4	29.8	36.1	30.4
344	SS113	40.6	45.5	37.0	41.0
345	STONEVILLE 7A	26.4	30.2	45.8	34.1
346	STONEVILLE20	44.4	42.2	46.7	44.4
347	STONEVILLE62	32.6	31.8	38.1	34.2
348	SUDAN ARBAN COTTON	18.4	20.0	25.0	21.1
349	SUMAN	28.2	31.1	43.3	34.2
350	SV213	34.1	32.2	40.0	35.4
351	T167	42.0	42.8	55.0	46.6
352	TAMCOT CAMPE	14.6	18.8	25.6	19.7
353	TAMCOT SP-37	32.8	31.8	33.3	32.6
354	TAMXOT SP23	13.4	23.3	26.8	21.2
355	TCH 1002	30.1	29.4	36.6	32.0
356	TCH1599	26.6	25.5	26.7	26.3
357	TEXAS31	40.2	38.8	51.3	43.4
358	TEXAS34	25.4	19.4	43.7	29.5
359	TEXAS44	26.6	25.5	41.7	31.3
360	TEXAS709	32.4	31.8	45.6	36.6
361	TEXAS79	24.6	21.2	33.3	26.4
362	TEXAS937	40.8	40.0	38.4	39.7
363	TH46	51.6	53.3	50.0	51.6
364	THAUNWAS	25.4	13.3	16.2	18.3
365	32 IC 333984	36.1	29.3	35.0	33.5
366	TSH1608	10.5	10.0	22.6	14.4
367	TX ORSZ78	36.4	33.3	37.0	35.6
368	UPA (57) 17	35.8	33.3	33.3	34.1
369	UPA(62)31-65	50.6	52.8	56.7	53.4
370	VCA2	28.2	39.3	48.3	38.6
371	VC-3	24.6	34.4	46.3	35.1
372	VCA6	44.2	44.4	53.3	47.3
373	VCA9	45.0	46.1	45.0	45.4
374	VCC22	42.6	40.6	48.3	43.8
375	VCC24	29.8	23.3	37.1	30.1
376	VCC3	36.6	35.5	44.4	38.8
377	VVCH1501	29.5	34.4	43.3	35.7

Table 3. Grouping of different genotypes based on their reaction to CLCuD

PDI	Disease reaction	Total entries	Genetic collection Name
0	Immune/Disease Free (0)*	0	-
1	Highly Resistant(0.1-10.0%)	0	-
2	Resistant(10.1-20.0%)	34	REBA PVT9 , PIL8, MC130, MC 82, 7203-14-104, P 729-37, H 1117, LUXMI, KDGH 50, TSH 1608, P 216-F, CSH 911, DELTA SL, PIL 8-7, BM COT 95–BLL, MAHALUXMI, PIL104, DELCERO, P367, BLIGHT MASTER, 101-102 B, THAUNWAS, CVT5, H14, SR38, 9-3X13L1CO2-1-3, MC 86, DHLYY, H 103, MCU 7, SLM 8, L759, TAMCOT CAMPE, 42-STONEVILLE 62
3	Moderately Resistant(20.1-30.0%)	134	GCOT12, 1556F, H655C, PUSA95, SUDANARBANCOTTON, RHC9740, TAMXOTSP23, ALBAR-7-MB, F1980, SA497, CIRPAN2362, AKH 2910, B143, GJHS53, BADNAWARI, GRS60-GIL3-4, PIL27, S44, KKS 4F, COTTON35, EC141679, F 1861, JK 344,CVT 6, RCMS 2B,KH138,AVB SM 277,1695-175 J, A02N 65, A03 N 150, F 414, L740-1, I81, KHD2, LAFRGOBRACT, GCOT8M, A03N139, S4727, A02N89, H1180, SHARDA, NCAC15, RS2097, 4SAMARU26, S101, GREGG45, H655C, COTTON5, PKV081, BNFREGOBRACT, P15CSH3050, PRS72, N3, PH348, BAN9561, DELCOT377, DELFOS, PUSA3216, SA305A, C100A, CPD032, LH1960, LH1995, RS2013, 91487, EPRT6, ACOLASJ1, BURI0394(1075)V, PUSA31, SCS523, L604, 101102B2, TCH1599, DSU28, TEXAS79, F1378, RED, PKV0804, A7262, COKER100, CSH36, KH155, SK663, BWR38562, LH1802, B56-181, HS100, 36B, GISV-12, JK105, SIMA1, ARKANSASGREEN, RAH3,G17, COKER210, NM755404, A03N153, GN671DWARF,LH1953, LAS45REDAK, F1875, JK97MB, KDGH504, ABOHAR3, PIL18, AMBASSADOR, LH1911, M8, PUSA864, SA72, DH21, EC132033, NHBBR38, 1412-A1, AKG3/62, N34, SAHANE, BATINROUGH, FM531BLINE-7, RAH53, RS2351, A0252, DUNN, GBHV148, LSS, TEXAS34, AKH8931, BURIO349(1075), GS10N, LASSANI 11, F1980, MDU5, GS23,
4	Moderately Susceptible(30.1-40.0%)	144	ABH6,H974,M11,PK54,VCC24, H1226,K4005,SR5, AMERICANNECTARILESS,EC141712, GJHS16, AKG2/54, F2035, MESR17, RS2390, AV3649, GICS15, PUSA180, SA7A, CNH151, KH113,EC356587,KKS,PIL9,GUMBO,76IH23, AKH9913,B68-1146, LRK516, RS89, IAN1327F, GJHS270, TEXAS44, A03N144,AO3N146,BR01-200/85, MZ561-3, S344, N86, PIL8-5, RS810, CNH120,GREGG35,TCH1002,16-SH-1274,GANGANAGERAGETI,BWR28, H1236,TAMCOTSP37,A03N148, PB557,PUSA1803, AVBNE165,CAK-PH93, PKY-RAJAT,AK-182/Gland361-3462,JK97-621,A03N124,A02N 106,IRMA-

			323,LSV24,L147, RHC1179,SA201,CCH510-4,EC124096,32-IC333984, GANGA,B57-876, AUBURN, G-OKRA, PIL20, RS875,S69-993, SIN8, JK345, STONEVILLE7A,UPA(57)17, CNH154, STONEVILLE62, SUMAN, PIL60, REX66,RH 1,AO2N75,CNH13,EC52SN, DELTAPINE(C5), GISV-86/58,G 67, RUU/U, PAYMASTER-III, A03N121, ATHENS1, G-245-10-2, LCMS6B, VCA3,49-CSH875, PARAS, SV213, NA1375 ,BJR592, COTTON4, FREGOBRACT, G205SA, HS182, TXORSZ78, ARB757, VVCH1501, 98-NHBBR44, LANKBURN, FFS103, SP84-213, GLCO2-4-4, BJR-JK97-164, RST9, LAM787, A02N84, COKER413, L11, A02N149, TEXAS709, GS10, IC1832, DC1-20, L762, RS2098, F1794, FS128, JP17, DCI116, AO2N40, NCAC11, JK255, SA1246, VCA2, B72-2889, DUNN56-C-B, VCC3, DP16, OKRAREDFREGO, GCOT100, TEXAS937, BHAGYA,
5	Susceptible(40.1-50.0%)	49	EMPIRE61,150-3-1-1, FD89, SS113, N72, SA1243, LH2001, PB84-RV4, PD380,F1914, ALBAR629,BC68-2, AKG2, REBA-B-50,AET55,43-P12, JPNo.9, R40,EC76765, BHATINDANo.1, H1150, NA920, TEXAS31, 59-SV7A, VCC22, C1412-A,SA1197, STONEVILLE20, KCL702, RHC2022, GTSV337, SA966, VCA9,CPD8-1, CA99541, COTTON14, GRS6015, T167, HS2, 33-STONE VILLE213, COKER310, LH2002, CNH36, LOCKET4789, VCA6,LAMGUNTURE,A03N132,F846,HS 251
6	Highly Susceptible(>50.0%)	16	G COT 8- F, AO3 N103, AVB SM 213, ANMOL, TH46,320-F, PUSA317, A02N 85, LCH-10, LOCKET4487, 78-CAT131, KDGH178, UPA(62)31-65, DHY286, HS6, JP-No8

cotton leaf curl virus disease and speculated on the possibility of the usefulness of this species in producing disease-resistant cultivated cotton by hybridization[2]. Nazeer *et al*., (2014) also indicated the possibility of transferring CLCuD resistant genes from *G. arboreum* to *G. hirsutum* through conventional hybridization and back crossing. 11600 genotypes were tested at Cotton Research Station, Vehari and demonstrated that it is possible to explore resistant material from germplasm through screening on the basis of incidence and intensity and the same can be utilized in the programme for evolving CLCuV tolerant/ resistant varieties of cotton[1]. Similarly in the present study, identified resistant genotypes may be utilized by the plant breeders for exploitation and providing leaf curl disease resistance in cotton as breeding for resistance essentially depends upon a constant supply of new source of resistance.

CONCLUSION

Cotton leaf curl has a very severe impact on cotton production and productivity. However, there is no resistance germplasm available against CLCuD. Evaluation of germplasm is the best way to overcome the effect of CLCuD and leads to the sustainable cotton production. Screening of germplasm is also a way of exploring natural variability present in an area leading to the selection of best genotype against CLCuD. Best resistant and moderate resistant genotypes may be recommended as variety at field level directly or also may be utilized as source of resistance in various breeding programms.

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