Behavior of Advance Cultivars of Cotton (*Gossypium hirutum.L)* against Cotton Leaf Curl Virus Disease (CLCuVD)

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Abstract

Twenty four lines of Bt-cotton each from private as well as public sectors and ten non-Bt-lines of both public and privates sectors were screened for their respond to cotton leaf curl disease (CLCuVD) under natural condition. Development of CLCuVD was recorded starting from 30 days after planting (DAP) till 120 DAP. The diseased reached to maxim after 90-120 DAP in all three sets. The strain BS-52 showed less disease incidence (49.3%) in set-I of private sector and strain CIM-616 also showed less susceptibility at day 60 after planting in Set-II (Bt-strains of public sector). In Set-III none-Bt strains of public and private sectors, Cyto-124 (7.7 %) and CIM-612 (19.2 %) showed minimum disease incidence and during 60 DAP and produced better seed cotton yield. Data of disease index and yield of seed cotton of all sets were regressed and showed significantly negative correlation.

Key words: Cotton, (Gossypium hirsutum), CLCuVD, lines, seed cotton yield, disease index

Introduction

Cotton (*Gossypium hirsutum* L) is leading fiber crop grown in more than 80 countries resulting in an annual production of about 20 million tones. In Pakistan cotton plays a key role as it is an important cash crop (Imran *et.al.* 2011). Due to its wide production and diverse uses, cotton is rightly considered as the backbone of Pakistan's economy. Pakistan rank fourth by area and production of cotton in the world (Mahmood, 1999).

Cotton plants are naturally susceptible to a large numbers of diseases. The actual number is still not known, but nearly 75 of cotton diseases have been described as pathogenic (Kirkpatrick &Rothrock, 2001). At present cotton leaf curl disease (CLCuVD) is a serious threat to successful cotton production in Pakistan. This disease is transmitted through whitefly (*Bemissiatabaci*).The CLCuVD is characterized by upward curling of leaves, thickening of veins and laminar outgrowth on underside of the leaf called 'enation'.

In the year 1991-92, CLCuVD affected 14000 acres in the Punjab (Ali *et, al*; 1996). The year 1992-93 was disastrous for cotton crop because of severity of the disease and large scale damage to the crop. In the Punjab, the lint cotton yields dropped from 849 Kg ha^{-1} in 1997-92 to 493 kg ha^{-1} in the following three years and the total losses up to 1994-85 are estimated around 3 million bales (Ali, 1997). After the development and construction of resistant varieties in the cotton belt, yield losses were recovered gradually and production (lint yield) regained to 643 kg ha^{-1}during 1999-2000 (Anonymous, 2001). In the year 2000-2001 a new strain of virus (CLCuVD) Burewala) appeared which effects on all the cotton varieties, previously resistant to CLCuVD (Mahmood*et.al.* 2003). Later on new strain of virus spread in different areas of the Punjab and caused severe losses.

Resistant varieties are the only permanent solution of the problem. During the last decade, considerable efforts have been made by different research organizations to develop CLCuVD resistant varieties. For a successful breeding programmed, a reliable screening technique is necessary to identify genetic resources. Current screening produce relies upon natural field infection.

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The objectives of this study are to test the yield as well as adoptability performance of candidate cotton varieties developed by different breeders of Pakistan. The studies were conducted to record natural incidence of disease as well as examine difference in varietal susceptibility to infection by CLCuVD, based on the symptoms, and correlation studies between yield in seed cotton and incidence of viral disease.

The incidence was determined by counting the healthy and diseases plants from the cotton field by the following formula:

Disease Incidence = Number of Diseased Plants / Total Plants X 100

At the end of the season (120 DAP) each and every plant was examined in the field and different grades/scale were allotted to them according to the level of infection in disease plants as described by Akhtar& Khan (2002). The rating scales are given in Table-1.

The disease severity and disease index was calculated by using the following formula:

Disease Severity = a* ($0^{\#}$) + a (1) + a (2) + a (3) + a (4) / Total Diseased Plants

Whereas *= Number of plants, # = Rating scale

Disease Index = Disease %age x Disease Severity/ Maximum Severity Value (4).

At maturity the crop was picked and calculated the yield in kg ha^{-1} and correlated with disease index which was recorded at 120 DAP. All the above data were subjected to standard statistical analysis (Steel *et. al.* 1996) and the means were compared using LSD test (P= 005).

Results and Discussion

Results of incidence of CLCuVD recorded (monthly interval) right from mid-June to mid-September (30 to 120 DAP) in all sets and are summarized in Tables 2 to Table-4. On an averages basis the disease start to appear at day 30 after planting (mid-June) but the incidence of the disease was low. The disease start to develop next 30 days (mid-July) and its flow increased gradually up to 90 (mid-August) and 120 (mid-September) DAP in all the three sets. The diseased reached to its maximum level (90-100%) at 90DAP (Table-2-4). The result indicates that the first thirty to sixty days are very important to manage the incidence of CLCuVD. These substantiated the findings of many scientists (Tahir*et.al.*, 1994 and 2005) who reported that the disease increased with the passage of time. The peak period of disease increased was found in the month of June and July (30 to 60 DAP). The cotton plant is susceptible to CLCuVD from four to fourteen weeks of age. At six week of age (45 DAP) most of the test lines/varieties developed disease symptoms, at the 10 weeks of age (75 DAP) all the test lines/varieties showed maximum increase in disease incidence but continue to develop disease until 14 weeks of the age (105 DAP) at slower development.

Varietal Behavior

Among different cultivars, the line BS-52 showed less incidence (49.3%)in Set-I, at day 60 after planting as compared to others. Later on all the lines showed equal behavior after 90 and 120 days of planting (Table-2).

Similarly in Set-II the line CIM-616 did not show any symptom of CLCuVD at days 30 after planting and also showed less susceptibly at day 60 after planting as compared to others. No variability among incidence of disease was recorded at day 90 and 120 after planting (Table-3). A little variability was noticed in disease index due to less intensity of disease in such strains (Table-5). A great variability about incidence of CLCuVD was recorded in Set-III. None of any symptoms of CLCuVD were recorded in Cyto-124, whereas CIM-612 showed only 1.3% at day 30 after planting. The incidence of disease ranged from 2.9 to 7.0% in others strains. The disease incidence increased during next 30 days except the two strains i.e. Cyto-124 (7.7%) and CIM-612 (19.2%). The rest of the strains showed incidence ranged from 52.9 to 85.3%. These lines showed highly susceptibility to CLCuVD after 3-4 month of planting. The line Cyto-124 showed incidence 25.2 and 28% at day 90 to 120 after planting respectively. Similarly in CIM-612 incidence goes up to 65% within four months of planting as compared to others strains i.e. 100% (Table-4). The above results indicate that the strains Cyto-124 and CIM-616 have some tolerance to CLCuVD. The results are confirmed with the previous finding (Hussain *et. al*, 1999) that the cultivar developed by CCRI, Multan showed resistance in the field.

Seed Cotton Yield and Disease Index

The data regarding the disease index and seed cotton yield of all sets are summarized in Table-5. It was observed that the yield of seed cotton is directly affected by disease index. If the disease index is low, got more yield of seed cotton and *vice versa.*

In Set-I the strains BS-52 produced seed cotton 2693 kg ha^{-1} with less disease index i.e. 78%, whereas the strain Sitara-13 having 85% disease index and produced 1683 kg ha^{-1} seed cotton. The behavior of others strains was remains the same.

The newly developed strains of CCRI, Multan & Cotton Research Institute (CRI), Faisalabad i.e. CIM-616 and FH-Lalazar produced 3361 and 3213 kg ha^{-1} seed cotton with the disease index i.e. 77 & 76 (Table-5, Set-II). Similarly, the strain RH-627, GH-142 and VH-305 produced seed cotton yield, 1494, 1782 and 2191 respectively with the same disease index (83.0%).

The data (Table-5, Set-III) showed that the difference in seed yield due to effect of CLCuVD were highly significant ($p \leq 0.01$). It is evident from the yield data that the strains Cyto-124 & CIM-612 showed less disease index i.e. 9 and 44% but produced maximum yield of seed cotton i.e. 2016 & 1712 kg ha^{-1} respectively. The findings were in accordance with those of (Ali e*t. al.* 2012) who reported that cotton crop more intact fruits that resulted in higher number of bolls with less percentage of cotton leaf curl virus infestation. Mahmood*et. al.,* (1995) also reported that the incidence of disease was lower and yield higher in CIM-240 and CIM-109 as compared to S-12 even in hot spots of CLCuVD.

Data of disease index and yield seed cotton of all sets were regressed. Results showed a negative correlation between seed cotton yield and disease index of all sets of NCVT (Fig-I).
In Set-I correlation between yield & disease index was recorded negatively, Y = -0.0027x 86.509, r = -0.421 (Fig-1a). Similarly the same condition was recorded in Set-II i.e. Y = -0.0023x 84.255, r =0.410 (Fig-1b). The same behavior of Bt. Strains was recorded either developed by public sectors, because both correlations have the same values. There is also negative relationship was found in Set-III, Y = -0.0411x 126.52, r = -0.638** and statistically significant, with respect of promising cotton strains (Fig-1c). It is evident from the above correlation that if the disease index is less then more yield is expectedand there will be great loss if disease index increased. The findings are in line with that of Ali *et. al.,*(2012). Moreover cotton strains Cyto-124 and CIM-612 performed better which might due to genetic makeup of the varieties as compare to others. However, the various production factors contributes to higher seed cotton yield still need to be studies to consistently obtain the most yield benefits.

Table-1 Disease rating scales for intensity of CLCuVD (Revised by Akhtar and Khan 2002).

Symptoms	Rating Scale	Symptoms	Rating Scale
Complete absence of symptoms	0	All veins involved and severe curling OR half of the plant affected	3
Vein thickening involving small groups of veins	1	All veins involved and severe curling and stunted plant OR whole of the plant affected and stunting	4
Large groups of veins involved and curling OR top of the plant affected	2	Enations	E

Table-2 Incidence of CLCuVD on National Coordinated Varietal Trial Set-I

Strains	CLCuD incidence(%age)			
	30 DAP	60 DAP	90 DAP	120 DAP
JS-1	5.4	80.7	100.0	100.0
BGC-09	3.2	78.5	98.1	100.0
Sayban-202	2.6	86.7	98.2	100.0
BS-52	0.9	49.3	97.8	99.5
Trend-1	0.8	70.6	100.0	100.0
Leader-1	2.1	66.2	99.6	100.0
Leader-5	3.1	69.7	99.5	100.0
Sun-1	3.1	63.0	98.3	99.1
Leader-3	3.7	62.8	99.1	100.0
AA-919	5.5	83.0	97.5	100.0
CA-926	3.7	82.4	100.0	100.0
Sitara-12	6.6	92.3	100.0	100.0
Sitara-13	5.9	88.0	100.0	100.0
AGC-777	2.8	64.7	100.0	100.0
AGC-999	4.0	72.5	99.5	100.0
Tarzan-3	2.6	90.7	100.0	100.0
Tarzan-4	3.0	80.9	99.6	99.6
Eagle-1	1.3	66.6	99.5	100.0
HS-81213	4.6	85.1	99.5	100.0
RCA-333	5.5	81.9	99.6	100.0
LS-62	2.4	69.5	99.1	100.0
Sahara-120	3.3	75.3	99.6	100.0
CIM-598	5.5	80.4	100.0	100.0
MNH-886	3.0	69.4	99.6	100.0
Average	**3.5**	**75.4**	**99'3**	**99.9**
Status	Non Sig	H. Sig	H. Sig	Non Sig
CD 5%		13.62	1.44	
1%		18.02	1.9	

DAP = Days After Planting Non Sig = Non Significant

H. Sig. = Highly Significant

Table-3 Incidence of CLCuVD on National Coordinated Varietal Trial Set-II

Strains	CLCuD incidence(%age)			
	30 DAP	60 DAP	90 DAP	120 DAP
NIAB-Bt-1	2.5	87.0	100.0	100.0
RH-627	1.3	82.0	100.0	100.0
BZU-75	1.7	56.2	99.2	99.7
GH-142	2.6	86.9	98.7	100.0
MM-58	1.3	62.3	99.6	99.6
IUB-13	1.3	65.0	98.7	100.0
VH-303	0.8	70.3	99.6	100.0
VH-305	2.5	86.1	100.0	97.4
CIM-600	1.6	87.2	100.0	100.0
CIM-616	0.0	42.1	99.2	100.0
Cyto-177	1.3	71.2	99.6	100.0
BH-180	2.5	79.2	97.4	100.0
BH-184	0.8	74.5	100.0	98.7
SLH-4	1.3	82.1	99.6	100.0
SLH-8	0.9	90.5	100.0	100.0
FH-142	0.4	56.1	100.0	100.0
FH-Lalazar	0.4	55.2	96.3	99.6
IR-NIBGE-5	5.0	75.9	100.0	100.0
IR NIBGE-6	0.8	74.1	99.6	100.0
CEMB-55	1.7	74.8	99.6	100.0
CEMB-66	1.6	80.0	100.0	100.0
MNH-988	1.3	75.6	98.7	100.0
CIM-598	3.2	82.5	99.1	100.0
MNH-886	0.4	54.2	98.4	100.0
Average	**1.6**	**73.0**	**98.3**	**99.8**
Status	Sig	H. Sig	Non Sig	Sig
CD 5%	2.29	15.91	-	1.3
1%	-	21.05	-	-

DAP = Days After Planting
H. Sig. = Highly Significant
Non Sig = Non Significant
Sig = Significant

Table-4 Incidence of CLCuVD on National Coordinated Varietal Trial Set-III

Strains	CLCuD incidence(%age)			
	30 DAP	60 DAP	90 DAP	120 DAP
CIM-612	1.3	19.2	43.8	65.0
Cyto-124	0.0	7.7	25.2	28.0
DNH-105	4.1	81.0	99.6	100.0
CRIS-533	2.9	81.8	100.0	99.0
MPS-27	3.7	85.3	97.1	100.0
BH-177	5.2	70.3	100.0	99.6
TH-112/05	4.9	76.0	99.6	100.0
PB-896	7.0	81.2	100.0	100.0
Sun-2	2.9	52.9	79.9	100.0
CIM-573	4.6	73.8	91.5	100.0
Average	3.6	62.9	83.7	89.2
Status	Sig	H. Sig	H. Sig	H. Sig
CD 5%	4.17	15.99	19.9	12.71
1%	-	21.16	26.45	16.82

DAP = Days After Planting
H. Sig. = Highly Significant
Non Sig = Non Significant
Sig = Significant

Table-5 Relationship between Seed Cotton Yield and Cotton Leaf Curl Disease Index

Set -I			Set-II			Set -III		
Strains	Disease Index	Yield Kg/ha	Strains	Disease Index	Yield Kg/ha	Strains	Disease Index	Yield Kg/ha
JS-1	82	1895	NIAB-Bt-1	80	1588	CIM-612	44	1712
BGC-09	79	2729	RH-627	83	1494	Cyto-124	9	2016
Sayban-202	81	1820	BZU-75	79	2810	DNH-105	74	1674
BS-52	78	2693	GH-142	83	1782	CRIS-533	79	1527
Trend-1	81	2377	MM-58	78	2500	MPS-27	78	1481
Leader-1	81	2321	IUB-13	78	2715	BH-177	77	1416
Leader-5	79	2239	VH-303	76	2125	TH-112/05	83	973
Sun-1	78	2291	VH-305	83	2191	PB-896	76	1644
Leader-3	80	2400	CIM-600	78	1920	Sun-2	75	1185
AA-919	79	1384	CIM-616	77	3361	CIM-573	76	828
CA-926	83	2126	Cyto-177	79	3221			
Sitara-12	85	1841	BH-180	80	1480			
Sitara-13	85	1683	BH-184	77	2437			
AGC-777	79	2356	SLH-4	82	1916			
AGC-999	79	2593	SLH-8	80	1877			
Tarzan-3	83	1764	FH-142	78	2768			
Tarzan-4	82	1787	FH-Lalazar	76	3213			
Eagle-1	79	2075	IR-NIBGE-5	79	2001			
HS-81213	83	1494	IR NIBGE-6	78	2430			
RCA-333	83	1616	CEMB-55	76	2563			
LS-62	80	2240	CEMB-66	78	2449			
SAHARA-120	80	2225	MNH-988	76	2608			
CIM-598	82	1743	CIM-598	80	1868			
MNH-886	81	2272	MNH-886	78	2668			
JS-1	82	1895	NIAB-Bt-1	80	1588			
BGC-09	79	2729	RH-627	83	1494			
Status	H. Sig	H. Sig	Status	H. Sig	H. Sig	Status	H. Sig	H. Sig
CD 5%	2.67	285.54	CD 5%	3.63	259.43	CD 5%	9.7	135.57
1%	3.53	379.15	1%	4.81	344.47	1%	12.84	182.5

Non Sig = Non Significant Sig = Significant H. Sig. = Highly Significant

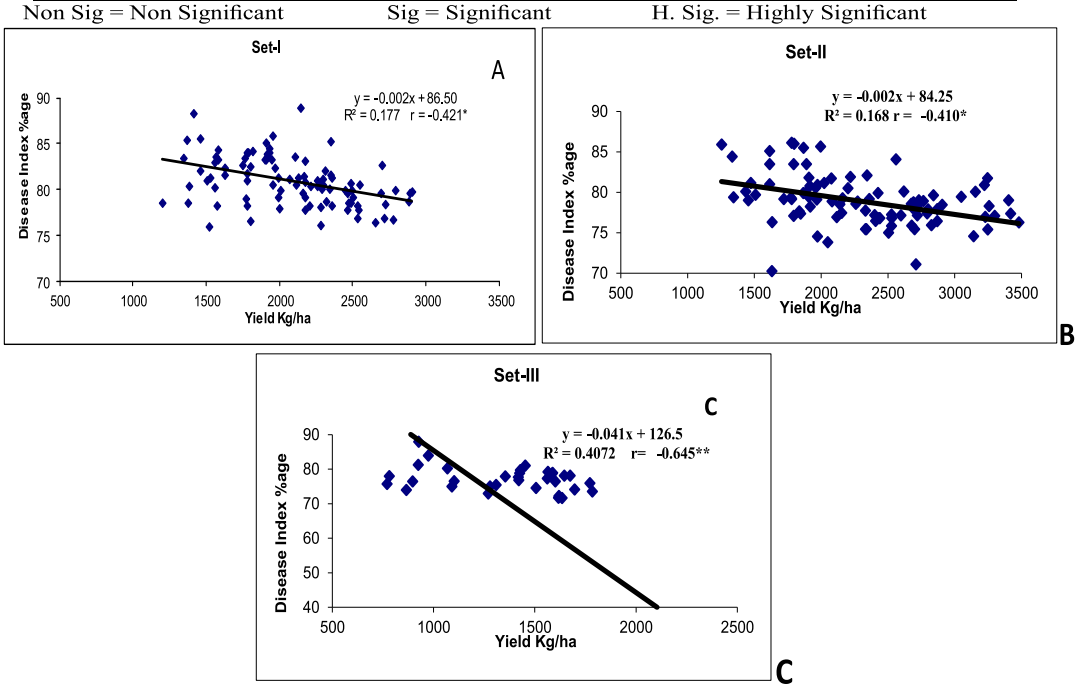

Fig-1 Relationship between Cotton Lea f Curl Disease Index and Yield of Seed Cotton

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