Epidemiological studies on Cotton Leaf Curl Disease on non transgenic genotypes in relation to environmental conditions

By

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Abstract

Studies were conducted on Cotton leaf curl disease (CLCuD) in relations to environmental conditions. Three non-transgenic genotypes viz. CIM-554, CIM-591 and CIM-608.were planted with 15 days intervals from 15th April to 15th June. Generally, 15th April planting showed significantly less disease incidence than all other sowing dates. The incidence increased as the sowing was delayed up to 15th June. The CLCuD boost up within 90 to 120 days after planting, regardless of sowing date and genotypes. The disease incidence increased gradually while CIM-554 gave maximum disease incidence than all other strains. The cultivars CIM-591 and CIM-554 showed no effect on the reduction of disease index on any planting dates, but however the strain CIM-608 showed some tolerance against the disease when planted on 15th April- 1st May. The maximum, 34.8~38.6°C, minimum 28.8~30.2°C temperature and relative humidity 67.8~75.4% favored CLCuD progression.

Key words: *Gossypium hirsutum* L., Cotton leaf curl disease (CLCuD), sowing dates, cotton genotypes, environmental conditions

Introduction

The cotton (*Gossypium hirsutum* L.) is comparatively more complex structurally than other major field crops due to its indeterminate growth habit. Vegetative and reproductive growth is a simultaneous process which proceeds up till the crop mature. However, growth and development of the cotton plant follow an orderly and predictable sequence where growing conditions are favorable. Although the sowing time is the most important management factors in all field crops however, cotton varieties may exhibit different behavior when sown under different sowing time.

The main reasons for low productivity are heavy attack by a number of insect-pests and diseases starting from germination up to the harvest of crop. Among the diseases Cotton leaf curl virus Disease (CLCuD) is the major reason for the decline in production and productivity in Pakistan, especially in the Punjab. This disease is caused by Cotton Leaf

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Curl Virus (CLCuV) which belongs to begomo virus family germiniviridae and interacts in persistent manner with the vector, whitefly (*Bemisia tabaci*). This disease is characterized by upward or downward curling of leaves. Veins of leaves become thickened, which is more pronounced on under side. The disease results in stunted plant growth with loss in yield (Hameed *et al*, 1994). The greatest damage and subsequent losses occur when cotton is infested at early growth stages. Late season infection result in only minimal damage (Tahir *et al*., 2004). Cotton leaf curl disease was reported for the first time in Pakistan during 1967 near Multan. At that time disease of minor importance and it did not get much attention. After 1988, the disease appeared in an epidemic form and damaged the crop on about sixty thousand hectares with a loss of 0.3 million bales in production (Mahmood *et al* 1999). The geographic spread of CLCuD has increased tremendously and more than 7.7 million bales of cotton has been lost due to CLCuD from 1986 to 2002 (Akhtar *et al* 2004).

Losses due to this disease depend upon the variety and sowing time of crop (Tahir *et al.,* 2004). Weather factors (individually and collectively) particularly temperature and relative humidity and rain fall, influence the disease development vector (whitefly) population to great extent in host pathogen system (Sharma *et al*, 2006). However, meager information is available on the role of climatic factors affecting vector population and disease development. The present studies were, therefore, carried out to understand the role of environmental factors on the development of CLCuD and effectiveness of planting dates and varieties on the incidence of CLCuD. The information thus generates, will be utilized in formulating the suitable integrated disease management, strongly against CLCuD.

Material and Methods

The Present studies were carried out at the Central Cotton Research Institute, Multan on silt loam soils during 2011. Three genotypes CIM-608, CIM-591 and CIM-554 were tested at five sowing dates i.e. 15th April, 1st May, 15th May, 1st June and 15th June at fortnightly interval to determine the response of cotton plant to CLCuD at different sowing dates under agro-ecological conditions of southern Punjab. The experimental site was situated at (30^{o}12 N, 71^{o}28 E) and altitude 123 meter (Hakoomat Ali *et al*., 2009). The treatments were allocated in split plot design with four replications. The crop was planted at a spacing of 75 x 30 cm by dibbler.

Observations on the incidence of CLCuD were recorded 30 days after planting and continued at 15 days interval up to 150 days for each planting variety. Total number of plants showing symptoms of leaf curl virus disease were counted every time during observations. Plant with even a single leaf showing the symptoms of disease were counted as infected.

The percentage disease incidence was calculated by using following formula:

$$\text{Percent disease incidence} = \frac{\text{Total plants} - \text{Healthy plants}}{\text{Total plants}} \times 100$$

At the end of the season (135 days after planting) 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 and Khan (2002). The rating scales are given in Table-1.

The percentage of disease index were calculated by using the following formulas

$$\text{Percent disease incidence} = \frac{\text{Sum of all disease ratings}}{\text{Total plants}} \times \frac{100}{\text{Maximum grade}}$$

The data on environment variable was obtained from Meteorological Department, Central Cotton Research Institute, Multan. Data for fortnightly progression of disease incidence was calculated and compared with environmental parameter (maximum, minimum temperature & relative humidity) of that period.

Results and Discussions

The incidence of CLCuD recorded fortnightly from 30 days after planting (DAP) from all planting dates is given in **Fig-1.** The pattern of appearance of CLCuD and its progression during the crop season differed greatly with the planting dates. Averaged across varieties, in 15th April sowing, the minimum CLCuD incidence of 5.91%,at 60 DAP, progressed to 40.0% within next 60 days. It is worthwhile to mention that in 15th April sown crop CLCuD did not appear after 30 days of sowing and it remained at the lowest level of 0.41% up to 45 days.

In 1st May sowing, the incidence level of CLCuD was 1.55% at 45 DAP which reached to its maximum levels of 50.44% at 135 DAP. While in case of 15th May sowing, CLCuD incidence of 8.28% at 45 DAP reached to its maximum level of 78.4% at 120 DAP. Similarly the incidence level of 1.82% at 30 DAP reached to 97.5% at 105 DAP in case of 1st June planting. The crop planted on 15th June fell prey to CLCuD showing 97.4% incidence within 60 DAP and reached to its maximum of 99.0% within next 30 days. A comparison among the varieties revealed that CIM-608 was the least affected with CLCuD, on average basis, at all sowing dates (**Fig-2**).

Averaged across cultivations, minimum disease index of CLCuD was recorded on crop planted on 15th April & 1st May followed by crop planted on 15th May. A little difference of disease index was recorded crop planted during 1st June & 15th June (Table-2). According to Sharma *et. al*., (2006), the disease incidence increase rapidly between the mid of June to the last week of July. Ghazanfar *et. al.*, 2007 also stated that sowing even earlier to 15th May may have more effect on reduction in disease incidence which needs to be tested.

Averaged across planting dates, minimum disease index (33%) was recorded on cultivar CIM-608 followed by CIM-554(59%) and CIM-591(60%) respectively (Table-2). On the basis of disease incidence and response to CLCuD index the strain CIM-608 showed some tolerance against the disease when planted on 15th April- 1st May. However, there was little difference of incidence and disease index when planted on 1st June to 15th June as well as with the comparison of other strains/varieties. The cultivars CIM-591 and CIM-554 showed no effect on the reduction of disease index on any planting dates.

These findings are similar to that of Tahir *et. al*. (2004) who found that of cotton cultivars under trial, the incidence was more on CIM-591 while CIM-608 showed lower attack as compare to others varieties. Akhtar *et al*. (2004) found that the age related to susceptibility to CLCuD was more apparent in late planting. Maximum increase in disease incidence was occurred at 6 weeks after sowing. The incidence of the different viral and fungal diseases is also influenced by altering the date of sowing as reported by Singh *et. al*.(1989) and Mirza (1992).

Effect of environmental conditions

The fortnightly increase in the disease comparison with environmental parameters of that period is given in Table-3. The fortnightly incidence of CLCuD when compared with the weather parameter it indicated that in 15th May sowing, maximum CLCuD incidence was recorded on 15th July i,e 22.2% only, when maximum temperature was 38.6°C, minimum temperature was 30.2°C and relative humidity was 67.8. It was concluded that if difference between maximum & minimum temperature was more disease incidence low and disease increases gradually during the period of June 30th to August 15th. It was also indicate that all the weather parameter was involved in the fluctuation of CLCuD. It was also observed zthat relative humidity also play an important role for the fortnightly increase of CLCuD when it remains below 60% there was no disease or minimal. Data indicated that maximum temperature ranged from 34.8 to 38.6°C, and minimum temperature 28.8 to 30.2°C with relative humidity 67.8 to 75.4 % favored for gradual increases of the CLCuD.

On an average basis of planting dates the maximum fortnightly increase of the disease started from 15th July to 15th August. The fortnightly increase of the disease remained low up to 30th June and same conditions was found after 15th August (Table-3)

It was clear that CLCuD increased gradually from 30th July to 15th August. It concluded that the disease does not express its symptoms if the temperature is greater than 40°C and less than 50% of Relative humidity during the early season of the crop. During the end of the season the disease also does not exhibit its symptoms if temperature is less than 34°C with greater than 80% Relative humidity. The results are in accordance with the finding of Sherma.*et.al* .2006. In this study it was concluded that disease was highly influenced by mean temperature and morning humidity. The morning Relative Humidity

and mean temperature explained the variability in disease incidence.

It was concluded that in early planting the disease low and on late planting the disease is high when the disease expresses its symptoms during 30th June to 15th August. In early planting the plant had strongly completed their vegetative growth while in late planting disease vigor come earlier when plants are tender. It is suggested that all planting should be done before 30th May to minimize the CLCuD.

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Table-1 Disease rating scale to use intensity of CLCuD for its Index

Symptoms	Rating Scale	Symptoms	Rating Scale
Complete absence of symptoms	0	Large groups of veins involved and curling OR top of the plant affected	4
Few small scattered vein thickening	1	All veins involved and severe curling OR half of the plant affected	5
Small scattered vein thickening	2	All veins involved and severe curling and stunted plant OR whole of the plant affected and stunting	6
Vein thickening involving small groups of veins	3	Enations	E

Fig-1 Incidence of CLCuD in different genotypes as influenced by planting dates

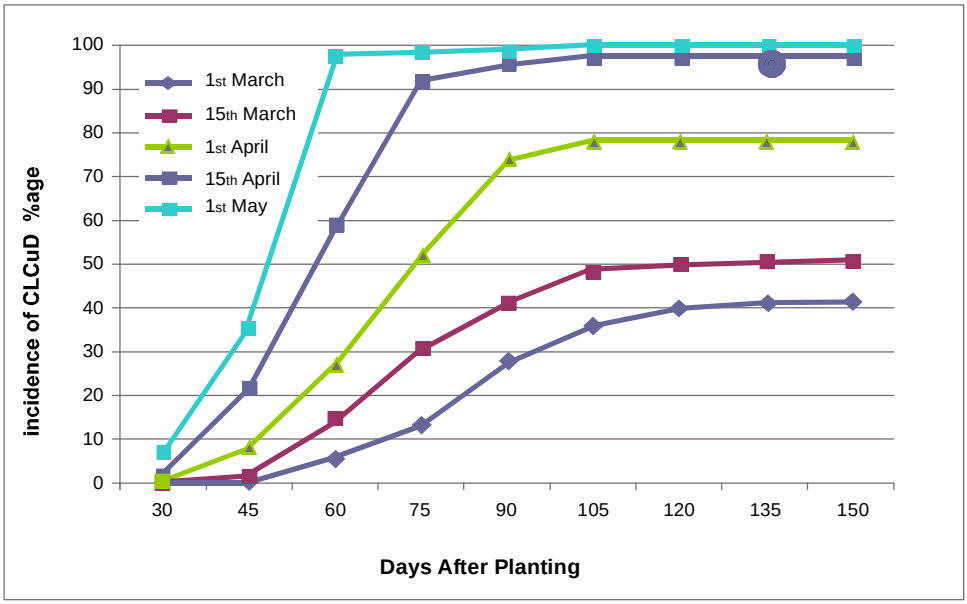

Fig-2 Effect of Non Bt. Genotypes on CLCuD Incidence

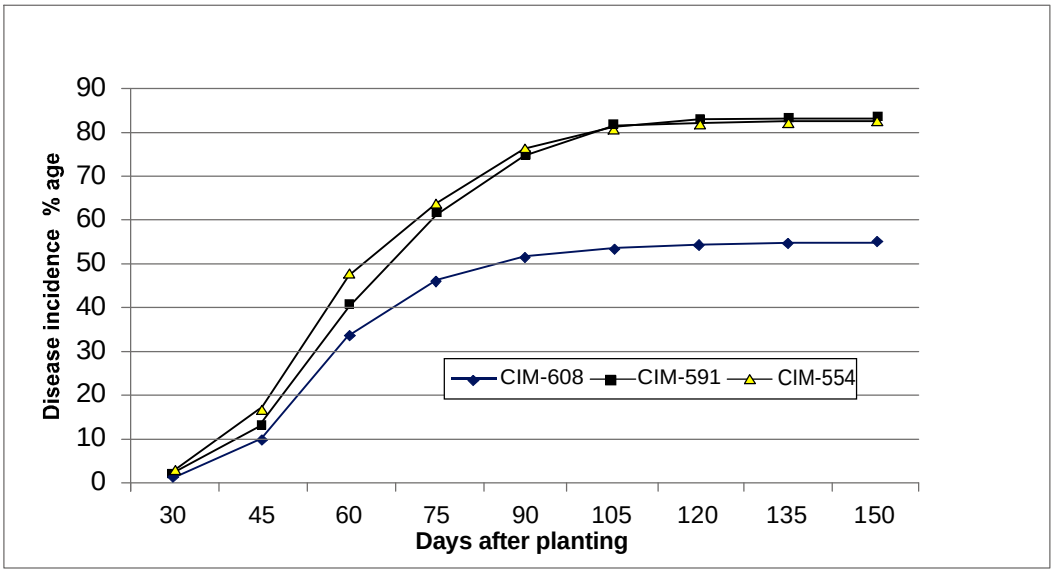

Table-2 Cotton leaf curl disease Index as affected by different sowing dates

Cultivars	Disease Index (%)					Average
	15th April	1st May	15th May	1st June	15th June	
CIM-608	.98	4.44	13.2	62.2	77.8	**33.3**
CIM-591	30.6	33.6	73.3	80.7	86.5	**60.9**
CIM-554	24.2	39.8	64.4	79.8	87.5	**59.2**
Average	**21.3**	**26.0**	**50.3**	**74.2**	**83.9**	

Disease Index= Disease incidence x Severity/ maximum severity value (6)

Table-3 Relationship between fortnightly increases in CLCuD with weather parameters

Planting Time	Fortnightly increase on									Cumulative disease incidence (%age)
	15th May	30th May	15th June	30th June	15th July	30th July	15th Aug.	30th Aug.	15th Sep.	
15th April	0	0.4	5.5	7.1	15.0	7.9	4.2	1.1	0.6	
1st May		0.0	1.6	10.3	15.8	10.8	7.1	1.3	0.4	
15th May			1.0	7.3	22.2	24.7	21.6	3.9	0.5	
1st June				1.8	19.7	37.2	33.2	3.5	2.0	
15th June					7.2	28.5	61.7	1.1	0.6	
Average				6.6	16.0	21.8	25.5	2.2	0.8	
Max. °C	39.8	41	40	38.6	36.6	36.5	34.8	34.3	32.3	
Min. °C	25.3	28.4	28.4	30.2	28.5	28.8	28.8	27.4	26.7	
Difference	14.5	12.6	11.6	8.4	8.1	7.7	6	6.9	5.6	