Influence of weather variables on Cotton Leaf Curl Disease (CLCuD) in cotton (*Gossypium hirsutum* L.) planted in three districts of the Punjab

By

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Abstract

The effect of Cotton leaf curl virus Disease and weather variables were studied for cotton plants, planted in different times (15th up to 23rd standard (std.) weeks with 15 days intervals) during cotton season 2009. Four cotton cultivars (CIM-496, CIM-557, CIM-588 and CIM-573) were planted in split plot in three districts (Multan, Sahiwal and Bahawalpur) Punjab. Weather parameters (Temp: Max. & Min., humidity and rainfall) were recorded of each district. The cotton cultivars planted on 15th and 17th Std. weeks showed less disease expression as compared to 19th, 21st and 23rd std. weeks of the year. The CLCuD took boost up during 27th to 31st std. weeks of the year, regardless sowing date and genotypes. At three spot the cultivars planted at different dates showed non-significant behavior with respect to disease incidence except the cultivars planted at 17th and 19th, std. weeks at Bahawalpur and Sahiwal spot. Average across the varieties planted at different sowing dates showed non-significant behavior. Max air temperature (38.2 ~ 42.7°C), minimum air temperature (26.1 ~ 28.3°C) and R.H (70.1 ~ 89.2%) of three locations favored CLCuD progression. However, weather variables (maximum. & minimum temp and R.H) are slightly differ within three district of Punjab.

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

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Introduction

Biotic and abiotic stresses are responsible for low yield in cotton. Among biotic stresses, Cotton leaf curl disease (CLCuD) has caused widespread problem (Manmood *et al.*, 1995). This disease is caused by a whitefly (*Bemisia tabaci*) Gennadius) transmitted Gemini virus (WTGs), known as Cotton leaf curl virus (CLCuV). This disease is characterized by upward or downward curling of leaves. Veins of the leaves become thickened, which are more pronounced on underside. The disease results in stunted plant growth with loss in yield (Hameed *et al*., 1994).

Cotton Leaf Curl, a viral disease of cotton, was reported for the first time in 1912 from Nigeria (Farquharson, 1912). Later on it was reported from Tanzania in 1926 (Jones and Mason, 1926) and from Sudan in 1934 (Baily, 1934). The disease did not receive much attention in the beginning due to its casual occurrence and minor economic importance. Since 1987 it has become a serious threat to Pakistan's cotton crop (Hussain and Mahmood, 1988). The disease-hit area was reported to be 97,580 hectares with a loss of 543,294 bales of cotton during 1992-93 seasons in the Punjab (Anonymous, 1992). A single viruliferous whitefly is sufficient for transmission of disease in a number of plants within a short span of time but efficiency is greater with more number of whiteflies.

Present studies were, therefore, carried out to understand the role of environmental factors on the development of Cotton leaf curl virus Disease and to develop multiple regression models for its prediction. The information, thus generated will be utilized in formulating the suitable integrated disease management. To develop CLCuV control strategies, the use of resistant varieties has been advocated as the most promising and least expensive method of disease suppression (Saleem and Haq, 1992). The aim of present study was to develop a correlation between environmental conditions and CLCuD.

Material and Methods

Present investigations were carried out under natural conditions at Central Cotton Research Institute (CCRI), Multan, Cotton Research Station, Sahiwal and Cotton Research Station, Bahawalpur.

Four cotton cultivars CIM-496, CIM-557, CIM-588 and CIM-573 planted on 15th, $17^{th,}$ 19^{th}, 21^{st} & 23^{rd} std. weeks of the year. Treatments were allocated in split plot design (main, planting dates and sub plot, cultivar) with four replications. The crop was planted at a spacing of 75 x 30 cm by dibbler. The conventional agronomic practices and plant protection measures were followed to keep the crop in good condition

Observations on the incidence of CLCuD were recorded 15 days after sowing and thereafter, continued at 15 days intervals up to 33^{rd} std. week of the year. Total numbers of plants showing leaf curl virus disease symptoms were counted every time during

observations. The percentage disease incidence was calculated by using formula:

$$\text{Disease incidence} = \frac{\text{Number of diseased Plants}}{\text{Total Plants}} \times 100$$

The data on environmental variables were obtained from three experimental stations i.e. Multan, Sahiwal and Bahawalpur for 15th to 33rd std. weeks of the year. The independent variable for correlation studies were temperature (maximum, minimum, average) and rainfall while the dependent variable was disease incidence

Result and Discussion

The spread of CLCuD was monitored right from two weeks after planting from all sowing dates from each location up to 33rd std. week of the year.

The fortnightly increase of CLCuD on different sowing dates at Multan location (Table-1) is more on crop, planted during 21st to 23rd std. weeks of the year as compared to 15th and 17th std. week of the year.

Impression of disease on crop planted during 15th and 17th std. weeks started from 23rdstd week of the year and continued up to 31st std. week of the year. The weather variables remained maximum temperature (37.2 to 42.7 ºC), minimum temperature (25.9 to 28.7 ºC) and RH 63.6 to 74.6 % during that period. While in planting on 19th to 23rd std. weeks of the year maximum disease symptoms appeared on 27th to 29th std. weeks of the year, when weather variables remained maximum temperature (38.5 to 42,7 ºC), minimum temperature (26.1 to 27ºC) with combination of RH (76.6 to 78.3 %) during that period.

These results showed that maximum increase of the disease was recorded during 27th std. to 29th std. week of the year in each planting. During that period the plant having less age showed more symptoms as compared to that having more age of the plant. The results revealed that in early planting, 15th std. week the disease was less while in late plating (21st and 23rd std. weeks) the disease was maximum.

The fortnightly increase of CLCuD on different sowing dates at Sahiwal location (Table-2) is more on crop planted during 23rd std. weeks of the year as compared to 15th and 17th std. week of the year.

Impression of disease on 15th and 17th std. weeks started from 23rd std. week when maximum minimum temperature and R.H% was 41.4 ºC, 25.4 ºC & 72.9%. At 29th std. week, maximum increase of disease was observed when 38.25ºC was maximum temperature, 28.35ºC was minimum temperature and 89.2% was Relative humidity while in planting on 19th std. weeks, disease symptoms appeared on 25th std. week when maximum temperature, minimum temperature and R.H% was 41.6ºC, 26.6ºC & 73.8% respectively and maximum

increase in disease was recorded on 27th to 29th std. week with weather variable maximum temperature (38.2 to 39.6 ºC), minimum temperature (26.1 to 28.3 ºC) and RH (88.9 to 89.2%) during that period.

The crop planted on 21st to 23rd std. week, showed maximum increase on 29th std. week of the year when maximum temperature, minimum temperature and relative humidity was 38.2 ºC, 28.3 ºC and 89.2 % respectively.

The fortnightly increase of CLCuD on different sowing dates at Bahawalpur location (**Table-3**) was maximum on crop planted during 21st to 23rd std. weeks of the year as compared to 15th and 17th std. week of the year.

Impression of disease on crop planted during 15th and 17th std. weeks started from 23rdstd week of the year and continued upto 29th std. week of the year. The weather variables remain maximum temperature (40.4 to 42.9 ºC), minimum temperature (25.1 to 28.4 ºC) and RH (69.8 to 72.0 %) during that period. While in planting on 19th std. week of the year maximum disease symptoms appeared on 27th to 29th std. weeks of the year, when weather variables remains maximum temperature (40.8 to 42,9 ºC), minimum temperature (25.1 to 28.4 ºC) with combination of RH (69.8 to 70.1 %) during that period.

The crop planted on 21st and 23rd std. weeks of the year maximum disease symptoms appeared on 25th to 29th std. weeks of the year, when weather variables remains maximum temperature (40.4 to 40.8 ºC), minimum temperature (25.1 to 28.4 ºC) with combination of RH (69.8 to 70.1 %) during that period. These results showed that on an average basis, maximum increase of the disease was recorded during 25th std. to 29th std. week of the year irrespective to planting dates.

On an overall basis of three districts, result revealed that expressions of Cotton leaf curl virus Disease on 15th std. week (mid-April) planting started from 21st std. week (1st week of June) and continued up to the 31st std. week (mid-August) of the year. The crop planted on 17th and 19th std. week of the years showed disease expression from 23rd std. week (mid-June) to 29th std. week of the year. The disease starts to appear from 27th (mid-July) to 29th std. week of the year on that crop which was planted during 21st and 23rd std. week of the year

These finding revealed that in late planting the disease reached at maximum level with in four weeks after planting where the crop planting earlier reached its maximal point with in 8 to 10 weeks. The result of present study corroborate with the finding of Tahir, *et al* (2004).

Last incidence of disease was recorded on 33rd std. week from all sowing dates and strains at each location. The data was analyzed and revealed that averaged across sowing

dates, the disease incidence was significant in Multan as compared to Sahiwal and Bahawalpur locations. Averaged across location, the minimum disease incidence was recorded on that crop which was planted on 15th std. week of the year as compared to all other planting dates. The other interactions were statistically non-significant (**Table-4**).

This is also clear from **Fig-1** that maximum disease incidence was recorded at Multan location as compared to others. In Multan district maximum air temperature remained high (1.9 ~ 4.5°C) and minimum air temperature remained low (2 ~2.2°C) during 25th std. week of the year than Bahawalpur and Sahiwal locations (**Table:1-3**).disease is more as compared to Sahiwal and Bahawalpur. In Sahiwal and Bahawalpur, maximum In early planting the disease is less and in late planting the disease is more because in early planting before the establishment of disease vigority the plants had strongly completed their vegetative growth while in late plating disease vigority come earlier when the plants are tedious.

Relationship among weather parameters and disease (CLCuD) incidence

The regression and correlation of different weather parameters (Maximum temperature, Minimum temperature and Relative humidity) and disease incidence are given in Fig. 2-4.

Result showed a positive correlation (y = 2.3077x - 48.878, r =0.31*) between average minimum temperature and fortnightly progression of disease (Fig-3). Maximum temperature and Relative humidity had positive but non-significant correlation with fortnightly increase of the disease (**Fig-2 & 4**). Other parameters had little effects on the progression of disease. These findings similar with Akhtar *et. al*. (2003), reveled that only minimum air temperature and plant age showed significant correlation with Cotton leaf curl disease while other factors are non-significant. Similar observations were reported by Sharma *et. al*. (2006).

It was concluded that in early planting the disease remained low and on late planting the disease was high. In early planting the plant had strongly completed their vegetative growth while in late planting disease vigor come earlier when the plants are tender. These studies confirm with 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. It should be suggested that all planting should be done on and/or before 21st std. week (May) of the year to minimize the CLCuD. To minimize the population of whitefly, plant protection measures should be adopted during the 27th to 29th std. week (July to mid-August) of the year.

Table-1 Fortnightly increase of Cotton leaf curls virus disease (CLCuD) on different sowing dates at Multan district

Sowing Time (Std. Weeks)	Fortnightly increase of disease (%age) on									Cumulative disease incidence (%age)
	17	19	21	23	25	27	29	31	33	
15	0	0	0.2	4.79	6.96	24.61	13.58	8.03	4.39	62.56
17	-	0	0	2.06	14.38	20.73	25.04	14.27	4.74	81.22
19	-	-	0	0.4	4.31	25.65	49.61	7.36	4.45	91.78
21	-	-	-	0	0.45	13.83	74.95	6.36	3.37	98.96
23	-	-	-	-	0	5.16	85.58	5.32	3.35	99.41
Average	-	-	-	-	**5.22**	**17.99**	**49.75**	**8.26**	**4.06**	-
Max. Temp. ºC	34.65	39.3	43.2	40.25	40.2	38.5	42.7	37.2	41.4	-
Min. Temp. ºC	18.9	22.9	26	25.4	25.9	27	26.1	28.7	26,2	-
R H %age	62.7	61.9	48.7	57.5	63.6	76.6	78.33	74.6	79.4	-

Table-2 Fortnightly increase of Cotton leaf curls virus disease (CLCuD) on different sowing dates planted at Sahiwal district

Sowing Time (Std. Weeks)	Fortnightly increase of disease (%age) on									Cumulative disease incidence (%age)
	17	19	21	23	25	27	29	31	33	
15	0	0	0.75	17.99	12.03	10.83	13.57	10.42	4.26	69.85
17	-	0	0	4.27	23.99	6.46	15.12	9.09	9.34	68.27
19	-	-	0	0.4	4.19	20.73	21.42	10.41	12.81	76.43
21	-	-	-	0	0.45	10.98	53.4	7.02	10.21	83.74
23	-	-	-	-	0	9.67	61.31	10.79	11.54	92.95
Average	-	-	-	-	**8.13**	**11.13**	**32.96**	**9.54**	**9.6**	-
Max. Temp. ºC	35.7	38.2	41.4	41.4	41.6	39.6	38.2	39.1	34.7	-
Min. Temp. ºC	20	22.5	26.5	25.4	26.6	26.1	28.3	28.7	25.2	-
R H %age	83.5	81.3	75.6	72.9	73.8	88.9	89.2	82.6	92.8	-

Table-3 Fortnightly increase of Cotton leaf curls virus disease (CLCuD) on different sowing dates at Bahawalpur district

Sowing Time (Std. Weeks)	Fortnightly increase of disease (%age) on									Cumulative disease incidence (%age)
	17	19	21	23	25	27	29	31	33	
15	0	0	0.92	14.39	14.59	10.58	13.95	4.34	2.33	-
17	0	0	4.54	20.27	10.4	24.36	3.56	2.33		-
19	-	-	0	0	6.54	27.04	33.31	3.21	4.18	-
21	-	-	-	0	20.0	20.59	43.04	3.37	2.11	-
23	-	-	-	-	8.95	27.91	50.83	2.59	3.44	-
Average	-	-	-	-	**14.07**	**19.30**	**33.09**	**3.41**	**2.87**	-
Max. Temp. ºC	38.9	40.2	43.8	41.7	40.4	42.9	40.8	39.2	36.8	-
Min. Temp.ºC	16.1	21.8	26.1	24.9	25.1	28.4	28.1	7.5	25.0	-
R H %age	73.4	70.9	68.7	72.0	69.8	69.8	70.1	74.9	81.6	-

Table-4 Analysis of variance of locations, sowing dates and other variables

SOV	d.f	SS	MS	F-Ratio
				N. S
Replication	2	193.20475	96.60238	4.85
				**
Main (M)	2	3818.182063	1909.091	95.81
Error (I)	4	79.7030567	19.92576	
				**
S. Plots (S)	4	23092.50293	5773.126	7082
M x S	8	3082.208031	385.276	4.73
Error (II)	24	1956.505243	81.52105	
				N. S
S. S Plots (S. S)	3	992.681289	330.48107	3.97
				N. S
M x S S	6	362.886478	60.48107	0.73
				N. S
S x S S	12	1262.84515	105.2371	1.26
				N. S
M x S x S. S	24	1820.299213	75.8458	0.91
Error (III)	90	7498.57235	83.31747	
	179	**44159.59062**		

C.V (1) = 5.56%

M=Location S=Sowing dates S.S. = Cultivars

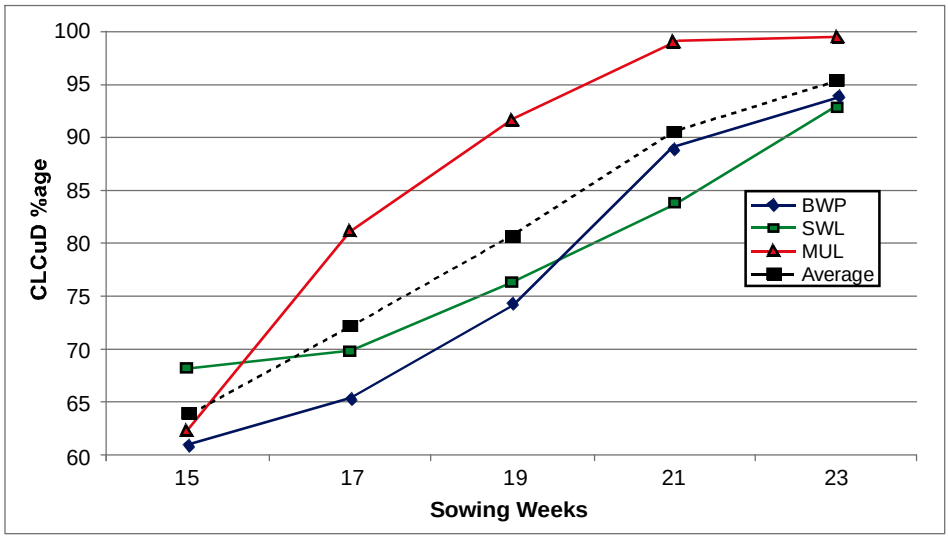

Fig 1 Incidence of CLCuD on different planting dates and different locations, recorded on 33rd std. week of the year.

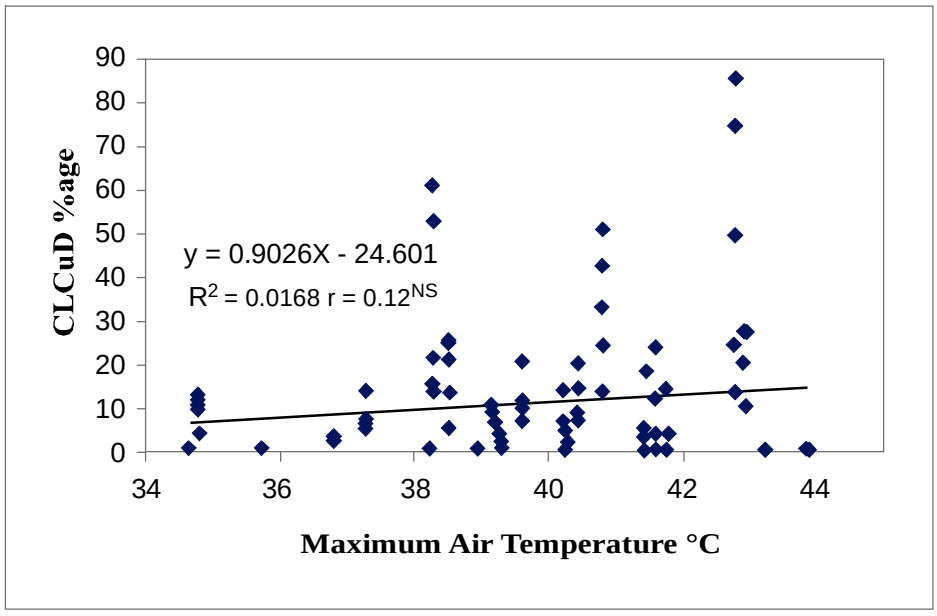

Fig-2 Relationship between fortnightly progression in CLCuD and maximum air temperature

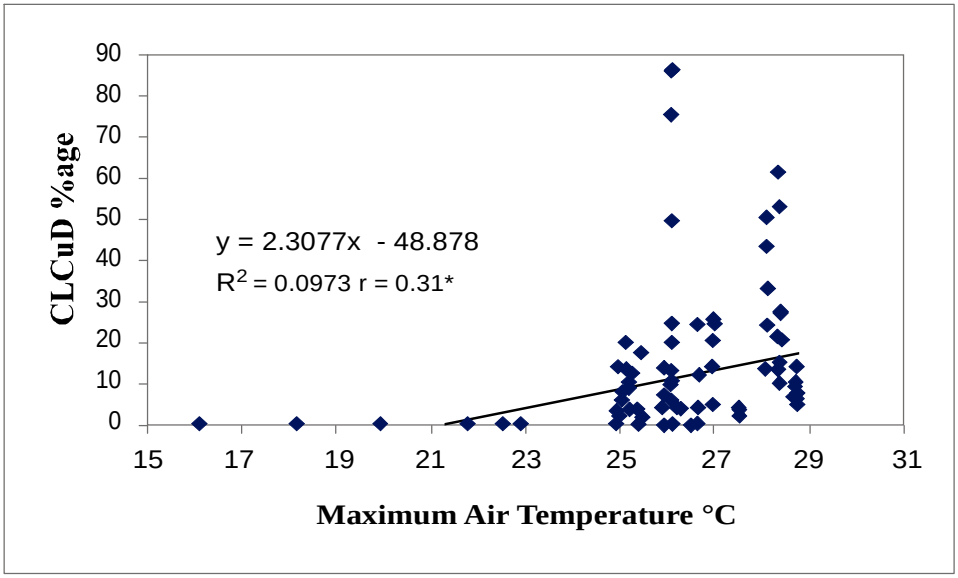

Fig-3 Relationship between fortnightly progression in CLCuD and minimum air temperature

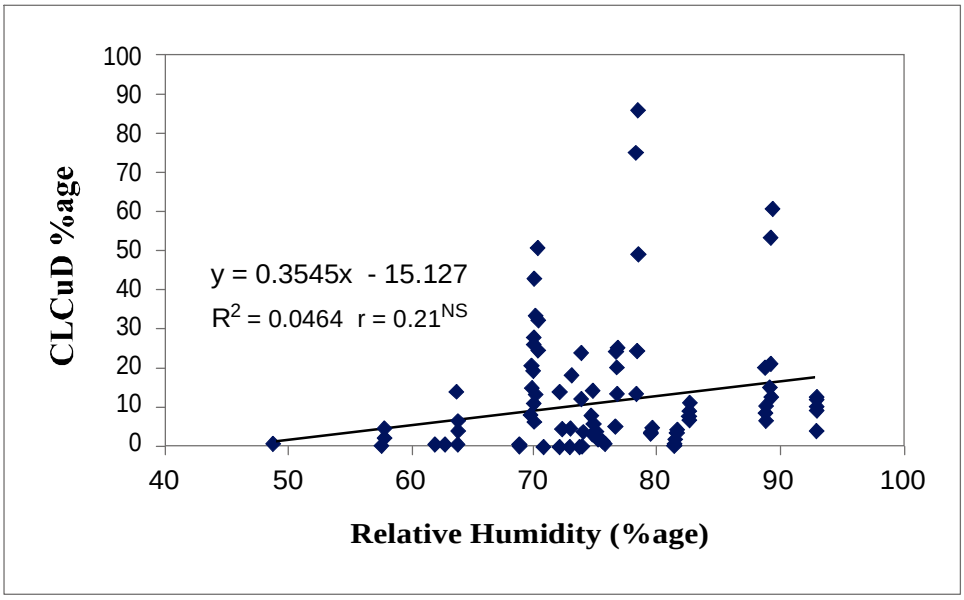

Fig-4 Relationship between fortnightly progression in CLCuD and Relative Humidity

References

Akhtar, K.P., M. Hussain, A. I. Khan, M. A. Haq, and M. M. Iqbal, 2004 "Influence of plant age, whitefly population and cultivar on infection of cotton plants by Cotton leaf curl virus(CLCuV) in Pakistan". Field Crop Res. 86: 15-21.

Akhtar, K.P., M. A. Haq, A. I. Khan and M. Hussain, 2003. "Cotton leaf curl virus disease in relation to environmental conditions in Faisalabad. Pak. J. Phytopathol, 15(1-2): 1-4.

Anonymous 1992. "Assessment of damage due to Cotton leaf curl virus in the Punjab", A Report, published by the Govt. of the Punjab, Oct, 31, pp9

Bailey, M. A., 1934. Leaf curl disease of cotton in Sudan *Empire cotton Gr.* Rev., 11(4): 280-288

Ferquharson, C. O 1912 "A report of the Mycologist", Agri. Dept., Nigeria, P. 196

Hameed, S., Khalid, S., Ehsan-ul-Haq, Hashmi, A. A. 1994. Cotton leaf curl disease in Pakistan caused by whitefly-transmitted Gemini virus. Plant Disease 78:528

Hussain, T., and M. Ali 1975 A review of cotton disease in Pakistan. *Pak. Cottons,* 19(2): 71-86

Hussain, T and T. Mahmood. 1988. A note on leaf curl disease on cotton. *Pak. cottons* 32(4): 248-250

Jones, G. H. and T. G. Mason 1926. Studies on on two obscure disease of cotton. *Ann Bot.* ,*1*,160: 722-759

Saleem A and, E. Haque 1992. "A report on the study of Cotton leaf curl virus in Sudan". P 17.

Sharma, J., Jagdish Beniwal and Anil Kumar.2006. 'Influence of weather variable on Cotton leaf curl virus (CLCuV) disease in cotton (*Gossypium hirsutum*)'.J. Cotton Res. Dev. 20(2):282-285.

Tahir, M., T. Mahmood, H .T. Mahmood and S. Hussain.2004, 'Effect of sowing dates on incidence of Cotton leaf curl virus on different cultivars of cotton'. Plant Pathology Journal 3(2):61-64.2004.