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Fibre Traits Analysis for Different Planting Times Under Diverse Incidence Levels of Cotton Leaf Curl Disease

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Abstract: Cotton leaf curl disease (CLCuD), is a serious threat in core cotton growing areas of Punjab (Pakistan), resulting in reduction of ginning out turn (GOT%) and deteriorating cotton fibre quality to a great extent, by comparing healthy and CLCuD infected plants was found. Abiotic & biotic factors such as white fly infestation, temperature and planting time effect cotton leaf curl disease epidemiology. The results showed that the physical properties viz; GOT %, was decreased significantly up to 11.03% and minimum decline was 0.51%. The maximum fibre length, was reduced 9.41% on 1st May sowing. The minimum value 78.5 of uniformity index (U.I%) was recorded on 15th March planting and a reduction of 9.02% in fibre strength and coarser micronaire value of -12.5 % due to CLCuD infestation for 15th March planting was witnessed.

Keywords: CLCuD, Cotton Fibre Properties, Planting time

1. INTRODUCTION

Cotton, the white gold" being a major cash crop of Pakistan, is grown in vast agriculture plains of Punjab and Sindh provinces. Its contribution in value added share is 5.2% in national agriculture and 1.0% in GDP; cotton made-ups cover about 2/3 export earnings of the country and textile which increases over $2.5 billion for the national economy; while ginning and textile industry heavily dependent on cotton. Mostly millions of farmers of both provinces are reliant on this crop, furthermore cotton value chain employed millions of people from yarn manufacturing to weaving or garments and textile exports. The cultivable area of cotton has been significantly increased in the last thirty years, in 2002-3 the area was 2794 thousand hectares as compared to 2902 thousand hectares in 2015-16. Pakistan rank 4th in cotton production and 3rd in consumption but on the other hand, per acre yield is stagnant from the years (lint yield per hectare in 2016-17 is 669 kg) due to which Pakistan rank 13th among cotton producing countries. Pakistan face the shortfall of around 1500-2000 thousand bales per annum that was fulfilled by importing to meet the local industrial demand (Economic survey of Pakistan, 2016-17). Now it is the need of hour to develop such kind of genotypes which can tolerate the biotic and abiotic stresses along with the quality fibre parameters to support the local industry of Pakistan. CLCuD became a serious risk to cotton production and quality in Pakistan from the previous two and half decade.A decline of 4.2 percent in productivity occur in the year 2012-13 when cotton production remained at 13.03 million bales compared to 13.60million bales in 2011-12. Production and yield per hectare remained less from previous year due to slight attack of thrips and CLCuvirus, lead to low production of cotton (Anonymous, 2012-13). Among the common intimidations, the utmost serious threat is cotton leaf curl disease and a great reduction in seed cotton yield and ultimately low production at country level occurred due to CLCudisease. Cotton leaf curl disease not only affected the lint yield but also stunted the plant growth due to which deterioration of fibre quality, lower the boll weight and reductionin seed index (Farooq *et al*., 2011).

Severe thickening of vein, curling and size reduction of leaves are the typical symptoms of cotton leaf curl disease. Productivity and plant stunting, leaf's spiral twisting, shortening of internodeand enations of veins are also observed (Akhtar *et al*., 2008). The CLCuD system has single-stranded DNA satellites connected with gemini viruses were recognized (Briddon and Stanley, 2006).Cotton leaf curl complex (Begomovirus, family Geminiviridae) have virus species are the cause of the CLCuD (Fauquet *et al*., 2008).

Cotton fibre quality is a major aspect that influence on price and quality of the textile products. Fibre length, micronaire value and strength are the main quality characteristics and the textile industry preferred long and strong fibres with low micronaire for making yarn of fine quality (Long *et al*. 2010). The versatility of

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cotton fibre and using widely in textile industry, but the deterioration of fibre quality characteristic due to CLCuD has not been identified. There is the demand for high quality fibre due to improvement in spinning sector, which has a significant influence on the whole cotton industry. Fibre staple length, micronaire, maturity, strength and uniformity are the most important fibre traits that have major impact in textile spinning (Arioli, 2005). Therefore, the present study was initiated to determine the impact of planting time and cotton leaf curl disease incidence on cotton fibre quality characteristics of two genotypes. Research findings from this study may deliver information not only to the growers of cotton but also to scientists and textile millsmanagersto assist in future planning.

2. MATERIALS AND METHODS

Two cotton genotypes viz., *Bt*.CIM-602 and *Bt*.CIM-632were sown at four different dates viz., 15th March, 1st April, 15th April and 1stMay during cropping season 2015-16 and 2016-17 in three replications by following RCBD at Central Cotton Research Institute (CCRI), Multan, Pakistan. Row spacing and distance between plant to plant were maintained at 75 cm and 30 cm respectively. Recommended agronomic practices were followed for better crop. About 4-6 weeks after sowing infected plants with CLCuD under natural exposure to the vector *Bemisatabaci* were tagged. Plant protection recommendation measures were adopted to avoid losses in yield and deterioration in fibre quality traits due to insect pests. Symptoms of CLCuD were verified and scaled by using the rating system of (Akhtar *et al*. 2008). 10 healthy and 10 virus affected plants of both genotypes for each severity levels i.e., mild, medium and severe were tagged in all replications. At maturity, fully opened cotton bolls werehand-picked from healthy and disease affected plants.

The seed cotton was ginned at miniature saw ginning machine to study GOT %. Cotton lint obtained was weighed and the GOT %was calculated using the formula: [(lint weight/seed cotton weight)× 100]. Before testing, lint samples were conditioned at standard atmospheric conditions (i.e., temperature 20±2ºC and RH 65±2 %). Fibre length and fibre uniformity index were measured on High-Volume Instrument (HVI-900A) length strength module-910, using an optical technique. Fibre length and fibre strength measurement were determined on the same module simultaneously. The micronaire value was estimated on micronaire module-920 by measuring the escape of air through a plug of a weighted cotton sample. Testing procedures were adopted as recommended by the ASTM Committee (2007).Theanalysis of variance (ANOVA) was applied to testing the significance level of treatments as suggested by Faqir (2000). Duncan's Multiple Rangetestused for individual comparison of means. The objective of the experiment was to study the effects of cotton leaf curl disease incidence on different fibre characteristics of cotton genotypes.

3. WEATHER DATA

Mean monthly metrological data during cropping seasons for the year 2015 and 2016 were collected from weather station of CCRI, Multan. The mean temperature, mean sunshine hours, total rainfall and mean relative humidityare shown in **(Table-1)**.

4. RESULTS AND DISCUSSIONS

The analysis of variance revealed that the both genotypes and as well as severity levels differ significantly for all fibre traits **(Table 2 and 3).** Both genotypes showed the symptoms of CLCuD with a similar infection type range but with variable incidences of infected plants. *Bt*. CIM-602 expressed severe level of incidence only in 1st May and 15th April 2015 sowing while *Bt*. CIM-632 showed severe level of incidence only in 1st May sowing while no plant of mild and medium level of incidence was witnessed.

Table-1. Monthly mean weather data from March to October.

Month	Temperature (ºC)		Rainfall (mm)		Sun shine hours		Relative Humidity (%)	
	2015	2016	2015	2016	2015	2016	2015	2016
March	20.2	21.9	92.9	20.1	6.8	5.2	73.3	77.5
April	28.5	28.5	9.2	13.1	8.3	7.5	65.3	86.0
May	32.6	33.4	8.5	2.0	9.0	5.9	53.1	74.3
June	33.3	35.5	24.5	4.0	6.6	3.4	56.1	69.1
July	31.3	33.1	151.2	36.2	6.8	7.0	71.5	73.0
August	31.5	31.6	67.0	109	7.7	7.0	77.6	84.6
September	30.9	30.5	15.4	4.0	7.2	8.1	85.2	82.6
October	26.6	26.9	7.0	-	7.3	7.0	73.5	68.8

Source: Central Cotton Research Institute (CCRI), Multan, Pakistan

5. GINNING OUT TURN (GOT%)

Reduction in ginning out turn in both genotypes was observed in experimental years due to CLCuD incidence. The maximum decrease (11.03%) in GOT % was found in *Bt*.CIM-632 sown on 15th March with mild severity level followed by the *Bt.* CIM-602 on 1st May, 2016 planting at severe level of disease with reduction of 9.55% while minimum decrease (0.51%) in *Bt*.CIM-602 at medium severity level of 15thMarch, 2016 planting as compared to healthy plants. In previous studies, Mahbub*et al*. (1995) revealed the reduction in ginning out turn up to 3.8% due to CLCuD also (Akhtar *et al*. 2009) concluded the negative impact of CLCuD on traits of fibre and these results illustrated the significantreduction of GOT% due to attack of CLCuD.

6. FIBRE LENGTH

Fibre length affects yarn strength, yarn appearance, processing waste and running quality. Generally, more uniform fibres produce yarns of greater strength. Therefore, cotton fibre length is a property of commercial value as price is generally based on this character. The importance of fibre length to textile processing issignificant. Longer fibres produce stronger yarn by allowing them to twist around each other more times. Longer fibres can produce finer yarns to give more valuable end products (Gamble, 2004; Arioli, 2005; Montalvo and Hoven, 2005). Fibre length was influenced negatively by the cotton leaf curl disease incidence for both genotypes. The maximum decrease (9.41%) in staple length was found in *Bt*.CIM-602 of 1st May 2016 sowing, with severe level of CLCuD followed by *Bt*.CIM-632 with 7.80% reduction on 1st May, 2016 planting withsevere level of disease while minimum decrease (3.86%) in *Bt*.CIM-632 on1st April, 2016 with medium level of CLCuD as compared to healthy plants. 3.9% reduction in staple length by CLCuD was already reported by Mahbub *et al.* (1995). Singh (2006) concluded that CLCuD reduced the fibre length by 5.2 %.Fibre length showed decreasing pattern with planting time in both genotypes which contradict with Hughes (1964) finding that late planting favour the staple length. The experimental conditions especially the temperature would be a possible cause for these diverse results. Fibre length of year 2016was lower than of year 2015 agreement with (Reddy *et al.* 1999) reported,the fibre length decreased withincreasing temperatureand insufficient moisture conditions.

7. UNIFORMITY INDEX

Uniformity index was influenced negatively by the CLCuD incidence for both genotypes. The maximum decrease (4.96%) in uniformity was found in *Bt*.CIM-632 sown on 1stApril, 2016 with medium severity level followed by *Bt*.CIM-632 with reduction of 4.18% on 15th March 2016 planting at medium severity level of disease while minimum decrease (0.14%) in variety *Bt*.CIM-632 (0.14%) on 15thMarch, 2015 with medium level of CLCuD severity as compared to healthy plants in agreement with Singh *et al.* (2009) found 1.1% reduction in fibre uniformity by CLCuD.

8. MICRONAIRE VALUE

Micronaire was significantly affected by the CLCuD incidence for both genotypes.The maximum increase(-12.5%) in micronaire was found in *Bt*.CIM-632sown on 15thMarch, 2016 with medium level of disease severity while minimum increase (-4.44%) in *Bt*.CIM-632 on1thMay, 2016 plantingwith severe level of CLCuD severity as compared to healthy plants.Monga *et al.* (1999) reported micronaire value of CLCuD infected plants was significantly higher than the healthy plants. Akhtar *etal.,* (2009) reported the deterioration of micronaire due to cotton leaf curl disease. Ali *et al.*(2009) also favour the early planting in Pakistan for better fibre traits. Micronaire value of year 2016 is coarser than of year 2015 this is probably due to the lower mean temperature of 2015 and also Reddy *et al.* (1999) resulted that the micronaire value increased with increasing temperature.

9. FIBRE STRENGTH

Fibre strength was influenced negatively by the CLCuD incidence for both genotypes. The maximum decrease (12.54%) in strength was found in *Bt*.CIM-632 on 15thApril, 2015 planting time with medium severity level followed by *Bt*.CIM-632 with reduction of 9.02% sown on 15th March, 2015 with mild severity level while minimum decrease (1.09%) in *Bt*.CIM-602 on 15thMarch, 2016 planting with medium level of CLCuD severity as compared to healthy plants.Ajmera (2000) also reported that up to (6.1%) reduction in fibre strength due to virus disease while 5.4 percent reduction in value of fibre strength was observed by Singh (2006). The decrease in fibre strength in year 2016 also observed with planting dates.

10. CONCLUSIONS

The cotton leaf curl disease has a significant influence on ginning on turn percent(GOT%) and other cotton fibre physical traits i.e. fibre length, fibre strength and micronaire value that could ultimately be reflected in yarnquality. These cotton fibre properties were significantly deteriorated by CLCuD incidence. CLCuD infestation varied between both genotypes, as dropin GOT %, decrease in fibre length, low fibre strength with coarse micronaire value as compare to healthy plants for same. Also, low infestation of CLCuD was observed on early planting in relation to late sown cotton.

Table-2. Fibre characteristics of Bt.CIM-602 at different virus severity levels

Characteristics	15th March 2015					1st April 2015					15th April 2015					1st May 2015				
	Healthy	Mild	Medium	Severe	%DOH	Healthy	Mild	Medium	Severe	%DOH	Healthy	Mild	Medium	Severe	%DOH	Healthy	Mild	Medium	Severe	%DOH
GOT %	39.1 a	39.1 a	38.9 a	-	0.51	38.4 a	37.6 b	37.6 b	-	2.13	40.0ab	38.9 b	40.7 a	-	2.75	41.9 a	40.6 b	39.8 c	37.9d	9.55
Length (mm)	29.9 a	29.4 b	28.7 c	-	4.01	29.8 a	29.2 b	28.2 c	-	5.37	29.3 a	28.5 b	27.4 c	-	6.48	28.7 a	27.3 b	26.0 c	26.0 c	9.41
Unif. Index %	81.8 a	80.8 a	80.1 a	-	2.08	79.9 a	79.2 a	79.0 a	-	1.14	79.2 a	78.5 a	78.8 a	-	0.51	79.3 c	81.2 a	80.5b	78.9 c	0.51
Micronaire	4.1 c	4.3 b	4.3 a	-	-4.88	4.5 c	4.8 b	4.9 a	-	-8.89	4.6 c	4.9 b	5.0 a	-	-8.70	4.9 d	5.0 c	5.1 b	5.3 a	-8.16
Str. (G tex^{-1})	30.4ab	30.6 a	28.3 b	-	6.91	30.8 a	29.7ab	28.5 b	-	7.47	29.2ab	30.1ab	31.0 a	-	1.37	31.5 a	28.9 b	29.2 b	29.2 b	7.88
	15th March 2016					1st April 2016					15th April 2016					1st May 2016				
GOT %	39.2 a	37.8 b	37.5 c	-	4.34	38.6 a	37.0 b	36.8 c	-	4.66	38.0 a	37.2 b	36.9 c	36.1 d	5.00	37.7 a	36.2 b	35.7 c	35.4 d	6.10
Length (mm)	29.4 a	28.6 b	28.3 c	-	3.74	29.2 a	28.2 b	27.6 c	-	5.48	28.9 a	27.8 b	27.1 c	27.0 c	6.57	27.9 a	27.6 b	26.5 c	26.4 d	5.38
Unif. Index %	83.5 a	82.7 b	82.4 c	-	1.32	80.6 a	79.9 b	79.4 c	-	1.49	81.9 a	81.5 b	81.5 b	81.0 c	1.10	80.1 a	79.6 b	79.4 c	79.0 d	1.37
Micronaire	4.4 c	4.5 b	4.6 a	-	-4.55	4.5 c	4.7 b	5.0 a	-	-11.1	4.7 c	4.9 b	4.9 b	5.0 a	-6.38	4.8 c	4.9 b	4.9 b	5.2 a	-8.33
Str. (G tex^{-1})	29.7 a	28.9 b	28.5 c	-	4.04	28.8 a	28.6 b	27.5 c	-	4.51	27.5 a	-	27.3 b	27.2 c	1.09	28.4 a	28.0 b	27.1 c	-	4.58

Values with different letters in each column of every date of sowing are statistically significant at p<0.05%DOH= percentage decrease over healthy

Table-3. Fibre characteristics of Bt.CIM-632 at different virus severity levels

Characteristics	15th March 2015					1st April 2015					15th April 2015					1st May 2015				
	Healthy	Mild	Medium	Severe	%DOH	Healthy	Mild	Medium	Severe	%DOH	Healthy	Mild	Medium	Severe	%DOH	Healthy	Mild	Medium	Severe	%DOH
GOT %	42.6 a	37.9 c	40.1 b	-	11.03	40.5 a	39.8 a	40.1 a	-	1.73	40.0 a	40.4 a	39.6 a	-	1.00	43.3 a	40.9 c	42.1 b	40.7 c	6.00
Length (mm)	29.3 a	28.4 b	28.0 c	-	4.44	29.5 a	28.8 b	27.9 c	-	5.42	28.7 a	27.8 b	27.6 c	-	5.92	28.6 a	28.1 b	27.5 c	27.4 d	4.20
Unif. Index %	79.6 a	80.4 a	78.5 b	-	0.14	81.4 a	79.0 b	79.4 b	-	3.04	80.2 a	79.1 a	79.9 a	-	0.37	80.8 a	78.8 b	80.5 a	80.4 a	2.47
Micronaire	4.0 c	4.3 b	4.5 a	-	-12.5	4.2 c	4.4 b	4.6 a	-	-9.52	4.3 c	4.4 b	4.6 a	-	-6.98	4.5 c	4.5 c	4.7 b	4.8 a	-6.67
Str. (G tex^{-1})	27.8 a	25.5 b	26.8ab	-	9.02	28.4 a	27.4 a	27.7 a	-	3.65	28.7 a	25.1 b	27.6 a	-	12.54	28.1 a	26.1 b	27.2 a	27.6 a	7.12
	15th March 2016					1st April 2016					15th April 2016					1st May 2016				
GOT %	43.3 a	42.0 b	41.0 c	-	5.31	42.2 a	41.5 b	39.9 c	-	5.45	42.0 a	41.1 b	38.6 c	-	8.10	41.1 a	-	-	37.9 b	7.79
Length (mm)	28.9 a	27.9 b	27.7 c	-	4.15	28.5 a	28.2 b	27.4 c	-	3.86	28.5 a	27.7 b	27.0 c	-	5.26	28.2 a	-	-	26.0 b	7.80
Unif. Index %	83.8 a	80.4 b	80.3 b	-	4.18	82.7 a	81.9 b	80.1 c	-	4.96	81.0 a	79.3 b	79.0 c	-	4.57	80.0 a	-	-	79.1 b	1.13
Micronaire	4.1 c	4.2 b	4.5 a	-	-9.76	4.2 c	4.3 b	4.5 a	-	-7.14	4.4 c	4.6 b	4.8 a	-	-9.09	4.5 b	-	-	4.7 a	-4.44
Str. (G tex^{-1})	-	-	28.0	-	-	29.0 a	-	27.7 b	-	4.48	28.7 a	27.9 b	-	-	9.76	27.5 a	-	-	26.8 b	2.55

Values with different letters in each column of every date of sowing are statistically significant at p<0.05%DOH= percentage decrease over healthy.

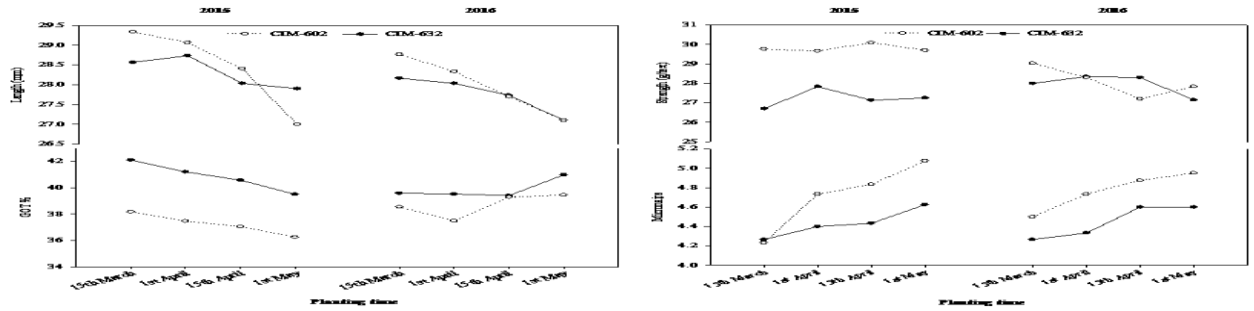

Fig. 1-Interactive effect of virus severity levels on fibre quality

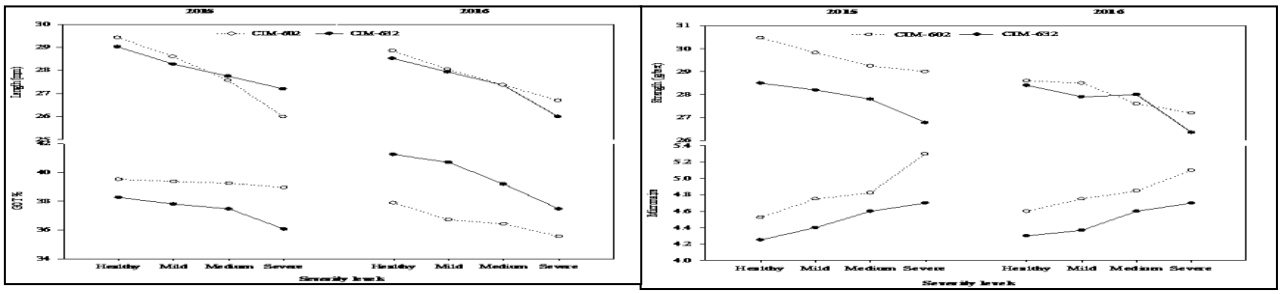

Fig. 2. Interactive effect of planting time on fibre quality

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