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Loss estimation in cotton due to cotton leaf curl disease under various sowing environments

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ABSTRCT : Cotton has great economic importance in Agricultural and Industrial development by earning foreign exchange through export of its raw materials as well finished product. Cotton leaf curl disease (CLCuD) is one of the major emerging threats responsible for decreased productivity and production in north western India. Two *Bt* cotton hybrids (SP7007 and Jai *Bt*) and two non *Bt* varieties (H1098i and H1300) were sown on three different dates of sowing at CCS Haryana Agriculture University, Cotton Research Station, Sirsa to determine seed cotton yield reduction. After 60, 90 and 120 days after sowing (DAS) all the plants showing symptoms of CLCuD were tagged and properly labelled. Early sown crop showed lowest percent disease intensity 16.7 per cent at picking in cultivar H1098i. Yield attributing characters of diseased plants decreased significantly on all the dates of sowing at all the stages (60, 90 and 120 DAS) of infection. Minimum mean reduction in bolls/plant, boll weight (g) and seed cotton yield/plant was recorded in early sown crop. Losses in yield attributing characters were more when CLCuD appeared at initial stage of infection *i.e.* 60 DAS. Conclusively, early sowing is recommended to avoid CLCuD infection.

Key words : Cotton leaf curl disease, loss estimation, sowing dates

Cotton occupies the most prominent position in the agriculture scenario of the country, as well as Haryana owing to its importance as a cash crop. It is known as the king of fibres and is also called as “white gold” playing a key role in many socioeconomic aspects of the world. In India, it occupies an area of about 118.81 lakh ha with total production 352 lakh bales and average yield is 503 kg/ha. In Haryana, cotton is grown on area of 5.76 lakh ha with total and average production of 14 lakh bales and 502 kg/ha, respectively (Annonymous, 2016). Several environmental calamities including both biotic and abiotic factors are the major threats to cotton production. Among several constraints Cotton leaf curl disease (CLCuD) is one of major responsible factor for decreased productivity in northwestern India. The disease caused by Cotton leaf curl virus (CLCuV) exclusively transmitted by whitefly first noticed in Nigeria on *Gossypium peruvianum*and *G. vitifolia*. CLCuD was first reported in India on American cotton (*G. hirsutum*) in Sriganganagar area of Rajasthan state during 1993 and during 1994 it appeared in Haryana and Punjab states on *G.hirsutum*cotton. In India, CLCuD is the major constraint of cotton production in north western region and causes yield loss to the tune of 79 per cent depending upon the stage of infection and cultivar (Hundal*et al.,* 2011). Amid various management factors to boost up per acre yield of cotton, resistant genotype selection,

optimal sowing time and higher plant density toning the ecological conditions of the region is the most important (Nadeem *et al.,* 2010). Source of resistance against cotton leaf curl disease also an effective tool to overcome the CLCuD incidence (Maharshi *et al.,* 2016; Yadav *et al.,* 2016).

The experimental material encompassed four cotton cultivars *viz.* Two *Bt* cotton hybrids (SP7007 BGII and Jai *Bt* BGII) and two non *Bt* varieties (H1098i and H1300). The experiment was conducted on three date of sowing *i.e.* 29th april, 2014 (1st date of sowing), 14th May, 2014 (2nddate of sowing) and 27th May, 2014 (3rddate of sowing) at CCS Haryana Agricultural University Cotton Research Station, Sirsa during *kharif,* 2014. Each sowing was done in a split plot design with four cultivars and replicated thrice.All conventional agronomical practices were followed to grow good crop. After 60, 90 and 120 days after sowing (DAS) plants showing symptoms of cotton leaf curl were tagged and properly labeled and numbered in all dates of sowing. Simultaneously, the plants which remained free from cotton leaf curl disease symptoms were tagged and labelled properly as healthy.

Observations recorded :

- Per cent disease intensity (PDI) was recorded as per the disease scale of All India Coordinated Cotton Improvement Project (AICCIP) and calculated by the formula given below:

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

- Yield component characters viz., Average boll weight (g), average bolls/plant and seed cotton yield (g/plant) of tagged healthy and diseased plants were recorded.
- Per cent loss in yield and other characters was worked out by the formula given below:

$$\text{Per cent loss in yield} = \frac{\text{Yield of healthy plants- yield of diseased plants}}{\text{Yield of healthy plants}} \times 100$$

Data analysis : Computer programme OPSTAT was used for all the statistical analysis of the research field data.

CLCuD is a big menace constituting a primary limit on the productivity of cotton. CLCuD disease appears in severe form causing heavy losses in cotton yield and productivity. It was found that among the three sowing dates, plants from 27th May sown crop showed highest per cent disease intensity (54.4, 39.2 and 29.7%) at picking in the Jai *Bt* hybrid from the plants tagged at 60, 90 and 120 DAS respectively. Whereas, plants from 29th April sown crop showed lowest per cent disease intensity (16.7, 18.3 and 23.3%) at the picking in cultivar H1098i tagged at 60, 90 and 120 DAS respectively (Table 1). Presence of CLCuD have potent impact on the number of bolls, boll weight and seed cotton yield on all three dates of sowing, in all four cultivars at all the stages of infection *i.e.* 60, 90 and 120 DAS. Number of bolls, boll weight and seed cotton yield of diseased plants also differed significantly as compared to healthy plants.

Maximum decrease in number of bolls

Table 1. Per cent disease intensity in cotton cultivars in different date of sowing

Date of sowing	Cultivar	Per cent disease intensity (DAS)		
		60	90	120
29th April	SP 7007	33.3	25.5	16.7
	Jai *Bt*	34.4	26.7	21.3
	H1098i	23.3	18.3	16.7
	H1300	31.9	21.6	16.7
14th May	SP 7007	41.6	26.6	23.6
	Jai *Bt*	41.7	31.1	23.3
	H1098i	33.3	31.9	23.6
	H1300	38.3	33.3	25.0
27th May	SP 7007	47.5	38.1	25.8
	Jai *Bt*	54.4	39.2	29.7
	H1098i	34.7	33.6	25.0
	H1300	41.7	34.4	25.3

was observed on 3rd date of sowing (28.09, 18.35 and 9.25 %); whereas, minimum on 1st date of sowing *i.e.*15.25, 7.69 and 2.84 at 60, 90 and 120 DAS respectively. Highest loss (28.09 %) was recorded in 3rd date of sowing at 1st stage of infection. The average loss in number of bolls of all the cultivars were 20.18, 11.91 and 4.76 per cent at 1st, 2nd and 3rd stage of infection respectively and overall mean reduction in number of bolls of all the four cultivars was 12.18 per cent (Table 2). Reduction in boll weight was observed high in 3rd date of sowing (8.35, 6.57 and 5.45 %); whereas, low reduction in boll weight was recorded on 1st date of sowing *i.e.* 6.09, 4.59 and 3.40 per cent at 60, 90 and 120 DAS respectively. Maximum loss (8.35 %) in boll weight was recorded on 3rd date of sowing at 60 DAS. The average per cent decrease in boll weight of all the cultivars was 6.82, 5.47 and 4.50 at 1st, 2nd and 3rd stage of infection, respectively; whereas, overall mean reduction in boll weight of all the four cultivars was calculated as 5.60 per cent (Table 3).

In line with other yield contributing characters, CLCuD also decreased the seed cotton yield (SCY) on all three dates of sowing. Maximum decrease in SCY (35.48%, 23.47% and 14.06 % at 60, 90 and 120 DAS, respectively) was observed in 3rd date of sowing followed by 2nd and 1st date of sowing. The average percent decrease in SCY of all the three sowing was 27.30, 17.50 and 9.63 at 1st, 2nd and 3rd stage of infection respectively. Maximum loss in SCYwas observed when disease appeared in initial stage of infection *i.e.* 60 DAS whereas, minimum in 3rd stage of infection *i.e.*120 DAS. The average percent reduction in SCY of all the cultivars were 25.88, 16.63 and 9.03 at 1st, 2nd and 3rd stage of infection, respectively and overall mean decrease in SCY of all the four cultivars was calculated as 17.18 per cent (Table 4). Early sowing is preferable to avoid CLCuD infestation in the field as there is less disease intensity as well as less impact on cotton production. The results are in agreement with the findings of Ali *et al.,* (2014) that early sowing reduces the problem of CLCuD and enhanced cotton productivity and delay in sowing cotton crop

Table 2. No. of bolls/plant of healthy and diseased plants and percentage reduction in number of bolls due to CLCuD in different cotton cultivars on different date of sowing

Treatment	1st Stage (60 DAS)		Loss/ reduction (%)	2nd Stage (90 DAS)		Loss/ reduction (%)	3rd Stage (120 DAS)		Loss/ reduction (%)	**Mean per cent reduction**
	Healthy	Diseased		Healthy	Diseased		Healthy	Diseased		
Date of sowing										
1st- 29th April	37.48	31.77	15.25	37.73	34.83	7.69	37.85	36.78	2.84	**8.59**
2nd-14th May	36.48	29.08	20.27	36.66	32.32	11.84	36.94	35.58	3.70	**11.94**
3rd-27th May	36.58	26.30	28.09	36.74	30.00	18.35	37.10	33.67	9.25	**18.57**
CD (p=0.05)	N. S.	2.37		N. S.	2.32		N. S.	2.30		
SE (m)	0.42	0.59		0.42	0.58		0.46	0.57		
Average			**21.20**			**12.63**			**5.26**	**13.03**
Cultivars										
SP 7007	46.30	34.92	24.57	46.53	39.63	14.83	47.00	43.44	7.57	**15.66**
JAI *Bt*	41.26	30.39	26.34	41.40	34.49	16.69	41.59	38.60	7.19	**16.74**
H 1098i	28.83	24.79	14.03	29.00	26.33	9.20	29.13	28.48	2.25	**8.49**
H 1300	30.99	26.10	15.78	31.23	29.07	6.93	31.47	30.83	2.01	**8.24**
CD (p=0.05)	1.34	2.28		1.30	2.30		1.58	2.38		
SE (m)	0.45	0.76		0.43	0.77		0.53	0.78		
Average			**20.18**			**11.91**			**4.76**	**12.28**

DAS= Days after sowing

Table 3. Boll weight (g) of healthy and diseased plants and percentage reduction in boll weight due to CLCuD in different cotton cultivars on different date of sowing

Treatment	1st Stage (60 DAS)		Loss/ reduction (%)	2nd Stage (90 DAS)		Loss/ reduction (%)	3rd Stage (120 DAS)		Loss/ reduction (%)	**Mean per cent reduction**
	Healthy	Diseased		Healthy	Diseased		Healthy	Diseased		
Date of sowing										
1st-29th April	3.97	3.73	6.09	4.01	3.83	4.59	4.03	3.89	3.40	**4.69**
2nd-14th May	3.93	3.69	6.11	3.97	3.75	5.57	4.01	3.82	4.69	**5.46**
3rd-27th May	3.87	3.55	8.35	3.88	3.63	6.57	3.91	3.70	5.45	**6.79**
CD (p=0.05)	N. S.	0.07		N. S.	0.12		N. S.	0.11	-	-
SE (m)	0.02	0.02		0.03	0.03		0.03	0.03		
Average			**6.85**			**5.58**			**4.51**	**5.65**
Cultivars										
SP 7007	3.90	3.59	7.75	3.91	3.71	5.33	3.95	3.79	4.18	**5.75**
JAI Bt	4.12	3.79	8.01	4.15	3.89	6.30	4.17	3.96	5.06	**6.46**
H 1098i	3.91	3.65	6.75	3.93	3.71	5.72	3.96	3.80	4.14	**5.54**
H 1300	3.76	3.58	4.76	3.79	3.62	4.51	3.84	3.66	4.63	**4.63**
CD (p=0.05)	0.08	0.12		N. S.	0.12		0.09	0.13		
SE (m)	0.03	0.04		0.03	0.43		0.03	0.04		
Average			**6.82**			**5.47**			**4.50**	**5.60**

DAS= Days after sowing

Table 4. Seed cotton yield (g/plant) of healthy and diseased plants and percentage reduction in yield due to CLCuD in different cotton cultivars on different date of sowing

Treatment	1st Stage (60 DAS)		Loss/ reduction (%)	2nd Stage (90 DAS)		Loss/ reduction (%)	3rd Stage (120 DAS)		Loss/ reduction (%)	**Mean per cent reduction**
	Healthy	Diseased		Healthy	Diseased		Healthy	Diseased		
Date of sowing										
1st-29th April	149.37	117.47	21.36	151.32	132.45	12.47	152.92	142.34	6.92	**13.58**
2nd-14th May	144.75	108.50	25.05	146.83	122.51	16.56	149.36	137.54	7.91	**16.51**
3rd-27th May	142.35	91.85	35.48	143.53	109.85	23.47	146.01	125.48	14.06	**24.33**
CD (p=0.05)	N. S.	14.70		N. S.	12.50		N. S.	12.02		
SE (m)	2.29	3.66		2.53	3.11		2.63	2.98		
Average			**27.30**			**17.50**			**9.63**	**18.14**
Cultivars										
SP 7007	180.46	122.92	31.89	182.41	147.66	19.05	185.81	164.96	11.22	**20.72**
JAI Bt	172.03	116.50	32.28	173.66	135.50	21.98	175.46	154.19	12.12	**22.13**
H 1098i	112.91	90.71	19.66	114.08	97.79	14.28	115.47	108.24	6.26	**13.40**
H 1300	116.56	93.62	19.68	118.76	105.47	11.19	120.98	113.09	6.52	**12.46**
CD (p=0.05)	7.16	12.28		7.50	11.35		19.95	12.28		
SE (m)	2.39	4.10		2.52	3.79		3.01	4.10		
Average			**25.88**			**16.63**			**9.03**	**17.18**

DAS= Days after sowing

reduced seed cotton yield progressively (Hussain *et al.,* 2015). Swami *et al.,* (2016) also found the significant role of early sowing to reduce CLCuD appearance. Similarly, it was also found that yield and yield attributes was significantly higher in early sown crop as compared to late sown conditions (Farooq *et al.,* 2011). Saeed *et al.,* (2014) reported that CLCuD exhibited negative and significant association with seed cotton yield and number of bolls.

The per cent reduction was more in *Bt* cultivars as compared to non *Bt* cultivars in all the stages of infection. This may be due to more PDI of cotton leaf curl disease in both the *Bt* cotton cultivars than non *Bt* cultivars as *Bt* cultivars are more prone to viral and white fly attack as compare to non-*Bt* cultivars.Similarly, Monga *et al.,* (2011) reported the percent loss in seed cotton yield due to CLCuD founded maximum in hybrid Jai *Bt* BG (54.1) followed by MRC 7361 BG (48.8) and Solar 76 BG (46.8). SCY reduction ranging from 15.7 to 56.7 per cent in popularly grown *Bt* cotton hybrids at different locations (Monga, 2014). All the aspects of research conclude as the CLCuD has a potential threat to cotton growing belt of India. CLCuD can be controlled by appropriate varietal selection and proper sowing time.

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