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Effect of Weather Variability on Phenological Stages and Growth Indices in Bt-cotton under CLCuD Incidence

Priyanka Swami[1]*, Anupam Maharshi[2] and Ram Niwas[1]

[1]Department of Agrometeorology, CCSHAU, Hisar, Haryana -125001, India.
[2]Department of Mycology and Plant Pathology, IAS, BHU, Varanasi-221005, India

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Cotton is the most vital role in Indian economy and industrial development. *Cotton leaf curl disease* (CLCuD) became major problems responsible for decreased productivity during last one and half decade. To find out the role of sowing environment on crop growth indices at different phenological stages, three *Bt*-cotton hybrids were sown at three different dates of sowings. Late sown crop shows a very poor growth having early occurrence of all phenological stages. Crop growth parameters viz. plant height, dry matter accumulation and LAI were higher in early sown crop as compare to late sown. In diseased plants phenological stages occurred earlier than the healthy plants and showed negative effect on all crop growth indices. Maximum impact of CLCuD on phenological stages occurrence was found at 50% boll formation stage in diseased plants of Pancham-541 in late sown crop. It was also found that effect of CLCuD was less in early sown crop and RCH-791 having some resistant reaction shows less impact of CLCuD. It concludes that early sowing was favourable for a better growth and reproduction of the cotton crop under the CLCuD incidence. RCH-791 may also recommend as best variety among all three for cotton productivity under CLCuD.

Keywords: Bt-cotton, CLCuD, Early sowing, 50% boll formation.

Cotton *(Gossypium spp.)* plays a dominant role in India's agrarian and industrial economy. The major use of cotton lint is for the production of a variety of fabrics and related products. Among several pest and disease CLCuD is major constraint responsible for lower productivity and production cotton. Maximum area under cotton cultivation in India is covered under *Gossypium hirsutum* (American cotton) varieties/ hybrids which are susceptible to CLCuD.

In India the disease was first reported on *G. barbadense* at Indian Agriculture Research Institute, New Delhi in 1989 then after reported on American cotton (*G hirsutum*) in Sriganganagar area of Rajasthan state during 1993[1] and during 1994 it appeared in Haryana and Punjab[8,9] states on *hirsutum* cotton and posed a major threat to its cultivation in northern India[10]. CLCuV as well as all the other 114 species of Begomoviruses are vectored exclusively by *B. tabaci*[5]. The typical symptoms of the disease include upward or downward leaf curling, dark green veins, vein thickening and enation that appeared in bead-shaped, small fine leaf like structures on the under surface of the leaves[2,3]. The severely affected plants have bushy appearance with dark green colour, short internodes without flowers and bolls[4]. Weather has a crucial role in disease development and its spread by its vector whitefly. Small alteration in sowing environment may become a very effective tool towards avoidance of CLCuD incidence on crop growth.

* To whom all correspondence should be addressed.
E-mail: priyankamah30@gmail.com

MATERIALS AND METHODS

The study was conducted at research farm of department of agricultural meteorology, Chaudhary Charan Singh Haryana Agricultural University, Hisar. Hisar is situated in the semi arid zone at an elevation of 215.2 m with a longitude of 75° 46' E and latitude of 29°10'N. Delinted and certified seeds of recommended SP 7007, Pancham 541 and RCH 791 of Bt- cotton cultivars were sown in three growing environments (10th May, 25th May & 9th June respectively) by hand plough, keeping a distance of 67.5 cm from row to row. Thinning was done one month after sowing maintaining a plant to plant distance of 30 cm. The following phenological observations were recorded:

(i) 50% Square initiation
(ii) 50% Flower initiation
(iii) 50% Boll formation
(iv) 50% Boll opening

Ø Plant height, LAI and dry matter were recorded on above mentioned phenophases.

Ø Online computer programme OPSTAT was used for all the statistical analysis (http://hau.ernet.in/sheoranop/) of the research field data.

RESULTS AND DISCUSSION

Cotton growth and development are greatly influenced by environmental circumstances, as well as seasonal management practices[7]. As the same way cotton leaf curl disease causes a severe impact on all crop growth stages including 50% squaring, 50% flowering, 50% boll formation and 50% boll opening and greatly influenced by environmental factors. It was found that all the phenological stages appeared early in CLCuD infected plants leads to poor growth and development of the plants. Maximum impact of CLCuD was observed at 50% boll formation stage of late sown crop in Pancham-541 cultivar. RCH-791 showed very low impact of CLCuD. Iqbal and Khan, 2010 also reported that different cotton genotypes behave differently with respect to seed cotton yield and resistance against diseases like CLCuV in different ecological conditions and management practices. Late sowing was unfavourable for crop growth and development showed early occurrence of phenological stages (Table no. 01).

All the crop growth indices i.e. plant height, dry matter and leaf area index also affected severely at various phenological stages under CLCuD infestation. Minimum plant height, leaf area index & dry matter recorded (112.71cm, 3.33 & 192.82g respectively) at 50% boll opening stage in late sown crop among all different dates of sowing. Among cultivars Pancham-541 showed minimum height & dry matter (109.72cm & 198.62g respectively) and SP-7007 having minimum leaf area index (3.21) at 50% boll opening stage. A significant difference was found between healthy and

Table 1. Appearance of various phenophases in different cotton cultivars under CLCuD incidence in different sowing environments

Treatment	50% square formation		50 % flowering		50% boll formation		50% boll opening	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
SP 7007								
10th May	46	41	70	64	97	90	133	128
25th May	44	40	67	63	94	86	130	125
9th Jun	42	39	65	62	91	85	128	124
Pancham 541								
10th May	50	44	75	68	102	91	136	130
25th May	45	41	70	65	98	86	134	129
9th Jun	44	40	68	64	94	86	131	125
RCH 791								
10th May	44	43	69	66	95	89	131	129
25th May	42	41	67	65	93	88	129	128
9th Jun	40	38	65	64	92	86	128	127

Table 2. Heights (cm) of cotton cultivars at different phenophases under CLCuD incidence in different sowing environments

Treatment	50% square formation		50 % flowering		50% boll formation		50% boll opening	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
Date of Sowing								
10th May	39.61	37.92	52.71	50.72	99.17	92.77	122.17	113.50
25th May	41.58	40.40	54.94	52.32	102.89	98.46	128.89	121.40
9th Jun	37.90	36.38	51.30	48.31	97.13	87.74	122.78	112.71
SE(m)	0.47	0.39	0.53	0.72	0.93	1.49	0.88	0.95
CD at 5%	1.91	1.60	NS	2.90	3.73	6.00	3.56	3.81
Cultivars								
SP7007	36.64	34.24	51.26	47.92	105.13	98.59	136.22	125.72
Pancham-541	40.01	38.98	52.98	51.21	97.89	88.06	117.88	109.72
RCH-791	42.43	41.48	54.72	52.22	96.17	92.32	119.73	118.43
SE(m)	0.47	0.42	0.67	0.70	0.86	1.18	0.85	0.73
CD at 5%	1.50	1.32	2.10	2.20	2.70	3.69	2.65	2.27

Table 3. Dry matter (gm/plant) of cotton cultivars at different phenophases under CLCuD incidence in different sowing environments

Treatment	50% square formation		50 % flowering		50% boll formation		50% boll opening	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
Date of Sowing								
10th May	22.50	22.12	57.31	56.41	127.72	122.83	231.67	216.70
25th May	23.61	22.99	58.31	57.41	135.26	131.02	242.26	235.36
9th Jun	21.87	21.21	56.87	55.26	125.67	120.24	219.23	192.82
SE(m)	0.42	0.40	0.55	0.60	1.50	1.29	5.75	8.29
CD at 5%	NS	NS	NS	NS	6.06	5.23	NS	NS
Cultivars								
SP7007	23.36	22.28	59.29	57.60	129.79	122.27	229.99	221.81
Pancham-541	22.11	21.91	56.46	55.86	126.29	123.40	228.83	198.62
RCH-791	22.51	22.13	56.74	55.62	132.57	128.43	234.33	224.44
SE(m)	0.64	0.60	0.40	0.34	1.44	1.40	5.04	5.60
CD at 5%	NS	NS	0.26	1.08	4.48	4.35	NS	17.70

Table 4. LAI (Leaf area index) of cotton cultivars at different phenophases under CLCuD incidence in different sowing environments

Treatment	50% square formation		50 % flowering		50% boll formation		50% boll opening	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
Date of Sowing								
10th May	0.33	0.28	1.08	1.06	1.71	1.52	3.85	3.62
25th May	0.43	0.36	1.29	1.10	1.85	1.64	4.03	3.77
9th Jun	0.29	0.24	1.08	0.94	1.57	1.36	3.65	3.33
SE(m)	0.02	0.01	0.05	0.02	0.03	0.03	0.05	0.06
CD at 5%	0.06	0.04	NS	0.10	0.15	0.14	0.20	0.24
Cultivars								
SP7007	0.31	0.27	0.98	0.94	1.60	1.42	3.51	3.21
Pancham-541	0.36	0.29	1.21	1.07	1.63	1.48	3.80	3.60
RCH-791	0.39	0.32	1.27	1.08	1.90	1.62	4.22	3.92
SE(m)	0.01	0.01	0.07	0.02	0.05	0.04	0.07	0.07
CD at 5%	0.05	0.03	0.23	0.08	0.16	0.15	0.21	0.22

diseased plants at all phenological stages regarding to crop observations (Table no. 02, 03&04). Similarly, Iqbal and Khan (2010) reported that CLCuD is caustic disease of cotton limiting vegetative growth and cotton productivity as well.

CONCLUSION

Altered weather patterns can increase crop vulnerability to infection, pest infestations. Cotton leaf curl disease has very severe impact on all growth parameters of the cotton and varies significantly according to sowing environment. Change in management practices may very potential tool to avoid CLCuD infestation. Under CLCuD infection plant shows early occurrence of phenological stages leads to disturbance of intensification of vegetative parameters. 50% boll formation stage has severely affected under CLCuD incidence. Early sowing is appropriate for Bt-cotton having timely occurrence of critical phenological stages and proper growth and development of the plants. Crop growth indices like plant height, leaf area index and dry matter potentially reduced under cotton leaf curl disease infestation. RCH-791 was minimum affected by CLCuD infestation may use as resistant cultivar directly in different breeding programme or may also recommend for field also.

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