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Status of cotton leaf curl virus disease and its vector whitefly in North India: A survey report

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Abstract
Bemisia tabaci (Gennadius) is a pest of global importance on herbaceous species. It causes direct damage by feeding and indirect damage through the transmission of plant pathogenic viruses, primarily begomoviruses. Monthly survey and surveillance of the whitefly was conducted in North India to map the temporal variation in its incidence on cotton, CLCuD was monitored. The survey revealed interesting facts of the whitefly and CLCuD.

Keywords: *Bemisia tabaci*, cotton leaf curl virus, survey, transmission

Introduction
Of the 1,200 whitefly (Hemiptera: Aleyrodidae) species that have been described to date, only a few species are economically important agricultural pests. *Bemisia tabaci* (Gennadius) has emerged as a major pest of cotton, vegetables and other crops in the tropical and sub-tropical regions of Asia, Africa, Australia, and America. Plant damage is caused by direct feeding and through transmission of plant diseases. Both adult and nymphs suck plant sap and deposit sticky honeydew excretion, which promotes sooty mould that interferes with photosynthesis activity and reduces quality of the produce. The whitefly is considered to be a highly cryptic species complex, with 24 genetic groups [1] and biotypes differ in host range, host plant adaptability, insecticide resistance and most importantly virus-transmission capabilities. During 1967, the incidence of CLCuD was first observed in the area of Multan city of Pakistan and this was the first evidence of occurrence of CLCuD in the Indian subcontinent [2, 3]. First evidence of CLCuD in India during 1989 was reported near the border area Sri Ganganagar, later it was spread as an epidemic form in 1994 [5]. The cotton production was very much affected by an epidemic of CLCuD during 1994. Later the disease spread rapidly throughout cotton-growing districts of North India. The virus can infect several collateral and alternate hosts that act as source of inoculums for its spread and perpetuation [6-8].
Early incidence (22nd standard week) of whitefly was observed in cotton growing areas of Haryana, Punjab and Rajasthan [9]. This early incidence of whitefly is most important in CLCuD hotspot area. Cotton growers of north India recorded heavy loss of cotton in 2015 cotton cropping season, largely due to direct damage by the whitefly [10]. To understand the cause for outbreak, the incidence of whitefly by random sampling method and CLCuD was mapped in 8 cotton growing districts of Punjab, Haryana and Rajasthan (Table 1).
The survey was conducted in 8 districts namely Sirsa, Fatehabad and Hisar districts of Haryana, Hanumangarh, Sriganganagar of Rajasthan, Fazilka, Bhatinda and Mansa districts of Punjab. The survey started from June when the incidence of whitefly starts, to the end of September when the populations decline and most of the surveyed locations are same throughout the season, only few locations are different in every survey. In Hanumangarh and Fazilka districts of the 8 surveyed cotton growing districts have recorded whiteflies above ETL with an average of 6.6 and 10.2 whiteflies per leaf (average of 10 plants) respectively in June. In July, only Fazilka, Mansa and Bathinda districts recorded whiteflies over and above the ETL with an average of 24.6, 10.3 and 12.6 per leaf, whereas in August whitefly did not cross ETL in any of the surveyed districts again in September month except Hisar (especially Hansi sub–divison), and Fatehabad districts of Haryana all the surveyed districts recorded whiteflies above ETL (Fig.1). This was especially true of districts in Rajasthan and Punjab where whitefly population grew exponentially with the development of black sooty mould on leaf (Fig.2).

Table 1: Locations and coordinates of surveyed cotton fields in North India during 2006.

Sr. no.	Location	District	GPS locations	
			Lattitude	Longitude
1	Mallekan	Sirsa	29 25 57.1	74 53 36.0
2	Kesupura	Sirsa	29 26 44.3	74 51 42.6
3	Kutabadh	Sirsa	29 27 15.1	74 47 51.0
4	Moju Khera	Sirsa	29 27 5.1	74 43 2.4
5	Nazadella	Sirsa	29 34 39.2	75 04 44.2
6	Surtia	Sirsa	29 48 37.6	75 11 19.8
7	Dariyapur	Fatehabad	29 31 11.1	75 28 50.8
8	Hanscolony	Fatehabad	29 30 0.19	75 26 8.16
9	Dangar (Arborium)	Fatehabad	29 37 58.6	75 30 49.4
10	Dariyapur	Fatehabad	29 31 11.1	75 28 50.8
11	Gujjarkhera	Hansi	29 05 55.2	75 54 20.1
12	Dana Kalan	hansi	29 04 52.4	76 01 41.1
13	Rakhisapur	Hisar	29 7 06.7	76 06 21.5
14	Panihari	Hisar	29 20 39.2	76 02 58.3
15	Agroha	Hisar	29 17 52.1	75 38 46.4
16	Rathikhera	Hanumangarh	29 32 37.7	74 32 45.9
17	Tibbi	Hanumangarh	29 33 28.7	74 25 38.1
18	Jandawali	Sirsa	29 38 03.0	74 14 45.6
19	Khanka	Sriganganagar	30 02 48.9	73 52 22.0
20	Hindumalkot	Sriganganagar	30 08 36.1	73 54 35.0
21	Sri ganganagar	Sriganganagar, ARS	29 56 03.9	73 53 22.0
22	Sardulgarh	Mansa	29 59 12.8	75 07 31.4
23	Tibbi (Harisinghwali)	Mansa	29 59 12.8	75 07 31.6
24	Sardulewala	Mansa	29 29 1.8	75 01 8.5
25	Lahri	Bhatinda	29 51 52.6	75 09 17.1
26	Talawandi Saboo	Bhatinda	29 59 37.7	75 04 53.5
27	Chanarthal	Bhatinda	30 07 44.6	75 08 01.8
28	Balluan takar singh	Fazilka	30 13 53.4	74 47 41.7
29	Farwnai	Sirsa	29 36 57.9	75 07 09.4
30	Sardhulgarh	Mansa	29 54 25.4	75 04 33.3
31	Kot fatta	Bathinda	30 6 25.5	75 03 45.6
32	Bathinda	Bathinda	30 10 56.7	74 57 39.0
33	Balluana	Bathinda	30 13 53.4	74 47 41.7
34	Abohar	Fazilka	30 09 49.1	74 15 12.0
35	Dangar khera	Fazilka	30 12 16.9	74 9 28.3
36	Mann	Muskar	30 5 18.2	74 39 7.4
37	Sirsa	Sirsa	29 32 34.0	75 02 20.1
38	Chikanwas	Hisar	29 16 40.4	75 38 17.6
39	Badopal	Fatehabad	29 25 57.7	75 32 14.3
40	Fatehabad	Fatehabad	29 30 0.19	75 26 8.16
41	Hisar	Hisar	29 16 40.5	75 38 45.1
42	Chhoti Mameran	Sirsa	29 27 04.3	74 42 33.2
43	Kharakheri	Hisar	29 22 1.5	75 35 04.2
44	Kishanpura	Hanumangarh	29 53 05.9	74 16 41.9
45	Ghallu	Fazilka	30 12 33.3	74 09 19.1
46	Himmatpur	Fazilka	30 00 24.7	74 23 55.0
47	Bhani bhag	Mansa	30 04 11.9	75 17 25.9
48	Maurmandi	Mansa	30 05 41.9	75 11 46.3

By the end of September of 2016, farmers took 6 to 8 need based sprays on an average in contrary it to 14 sprays or more with mixtures of not less than 3 insecticides and fungicides per spray, in 2015. The increase in whitefly population in September was due to frequent and increased number of sprays associated with favourable weather for the pest multiplication. The factors responsible for whitefly outbreak in North India were identified as late sowing, use of susceptible Bt hybrids, excessive application of nitrogenous fertilizers, indiscriminate insecticide use, both singly and as mixtures and most importantly, favourable climatic conditions, like low precipitation and consequent prolonged dry spell.

The 2016 season recorded lower whitefly incidence and sooty mould growth. The change in scenario of incidence and damage of whitefly may be attributed to early sowing, adoption of tolerant hybrids, judicious use of nitrogenous fertilizers, use of neem based formulations, less number of indiscriminate spraying of insecticides both singly and mixtures, favourable climatic conditions, timely need based advisories issued and awareness created by the ICAR-CICR and respective state agricultural universities.

Along with whitefly, CLCuD was also surveyed to ascertain the extent of incidence and severity (Table 1). To record the per cent disease incidence disease grading (0-6 scale) technique developed by AICRP on cotton was adopted [11]. Various kinds of symptoms *viz.*, vein thickening, upward and downward curling (cupping), mottling/crinkling and cup shape outgrowths or enations on the lower side of the infected leaves was recorded (Fig. 3). The disease progression was

very slow except along the Indo-Pak border of Hindumalkot of Sriganganagar district of Rajasthan and some locations of Sirsa district of Haryana (Fig. 1). During June, CLCuD incidence was observed only at one location of Hanumangarh district where the whitefly infestation was above ETL. Thereafter the disease progression that started in July spread in all the cotton growing districts of North India. The peak disease incidence was recorded in August in Sriganganagar district, whereas disease grades in Punjab increased in September. But in Hanumangarh, Sriganganagar and Faridkot districts, disease incidence increased consistently during the season and were identified as the hotspot area for CLCuD.

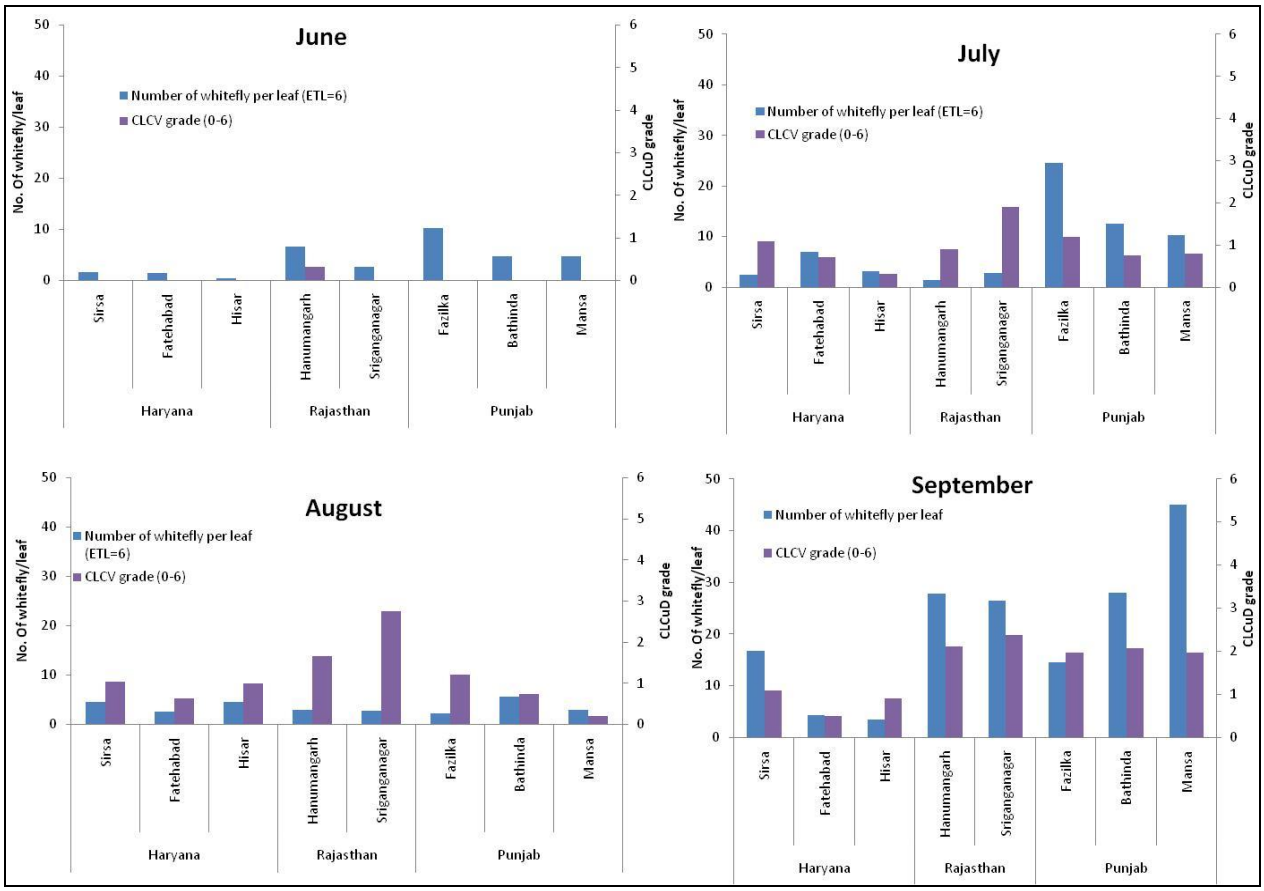

Fig 1: Month wise whitefly and CLCuD incidence in Haryana, Punjab and Rajasthan during 2016 cotton season.

Fig 2: Severely whitefly infested cotton leaf and sooty mould developed cotton plants in the field.

Fig 3: Various symptoms produced by ClCuD infected plant 1) Vein thickening 2) upward curling/ cupping 3) Down ward curling/ cupping 4) Enation 5) Mottling/Crinkling

Disease incidence and severity was not much correlated with the number of whiteflies in the fields of surveyed locations (Fig.1). It was noticed that the fields having severe incidence of CLCuD had less infestation of whiteflies and vice versa. Incidence of viruliferous whiteflies is necessary for incidence and spread of CLCuD. In addition enation or the cup shape outgrowth was not related with the disease severity and is speculated that enation may be related to strain variation. There is need to study the genetic diversity of this important viral disease so that the dominant strain of the virus can be identified.

The results of survey gave insights about the whitefly outbreak during cotton growing season 2016 in north India. The dynamics of whitefly varied both spatially and temporally. Symptoms of CLCuD also varied geographically. It was not possible to draw a correlation between the number of whiteflies and intensity of CLCuD or disease grade in our study. In light of these observations crop windows vulnerable to the vector or/and the disease were identified in 8 districts so that pest management can be effective.

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