

Yield and fibre quality associated with cotton leaf curl disease of Bt-cotton in Punjab

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Publication Info

Paper received:
17 September 2011

Revised received:
09 February 2012

Accepted:
22 March 2012

Abstract

Cotton leaf curl disease (CLCuD), caused by Gemini virus and transmitted through whitefly (*Bemisia tabaci*) is a serious problem in Northern India, affecting the productivity to a great extent. Depending upon the severity of infection in susceptible varieties, the disease can cause upto 90.0 % yield losses besides this, it also causes deterioration in fibre quality. The objective of the present study was to determine the effect of cotton leaf curl disease on seed cotton yield and fibre characters of two popular Bt-cotton hybrids in Punjab. The disease caused 52.7 % reduction in number of bolls and 54.2 % in boll weight in Bt cotton hybrid RCH 134. Similarly, it reduced the fibre length from 29.1 to 26.2 mm (9.9%); fibre uniformity from 68.9 to 68.1 % (1.1%); fibre strength from 29.1 to 26.9 g per texture (7.5%) and micronaire value from 5.2 to 5.0 g inch⁻¹ (3.8%). Similar results were reported in Bt cotton hybrid MRC 6304, where the disease reduced the boll number and boll weight by 46.1 and 43.4 %, respectively. However, the fibre quality was not much affected by varying level of disease severity. The studies clearly reflect the adverse impact of CLCuD on yield and fibre quality especially 2.5% span length. Thus suggesting the management of disease using integrated disease management strategies to avoid quantitative and qualitative losses.

Key words

Bt- cotton, Cotton leaf curl disease, Fibre quality, Seed cotton yield

Introduction

Cotton is one of the most important cash crops in India. Although India has the largest area under cotton (about 11.0 m ha), the present lint productivity of 503 kg ha⁻¹ is very low in comparison to Australia (1942kg ha⁻¹), Brazil (1460 kg ha⁻¹), China (1260kg ha⁻¹), Turkey (1245 kg ha⁻¹), Egypt (1905 kg ha⁻¹) and USA (868 kg ha⁻¹) (Anonymous, 2011). In Punjab cotton is being cultivated in about 0.5 m hectares area with a total production of 16-17 lakh bales and productivity of 528 kg ha⁻¹ (Anonymous, 2011). Cotton leaf curl disease is amongst major factors for the low productivity especially in North India. It adversely affects yield and quality characters of upland cotton. The disease recently known to be caused by DNA-A/DNA-1/DNA beta complex of whitefly transmitted Gemini virus (Briddon *et al.*, 2001) The first symptoms of disease on cotton in Punjab appeared in 1995 and the disease continued to spread steadily eastwards in Punjab, Rajasthan and Haryana states

(Briddon, 2003). Presently it has assumed serious proportions in the irrigated cotton belt of North India (Monga *et al.*, 2004).

Depending upon the stage of crop and intensity of disease, the loss in seed cotton yield varied from 10.5 to 92.2% in susceptible varieties of upland cotton (Singh *et al.*, 1995; Monga *et al.*, 1998). The incidence or outbreak of disease has resulted in varying degree of losses reported from different parts of world, 30-40 % yield loss in Gezira and Sudan (Tarr, 1957), 50 % decrease in average yield and 33.4 % reduction in boll weight, and 72.3 % in number of bolls in Pakistan (Shafique *et al.*, 1994), 68.1-79.2 % reduction seed cotton yield in India (Monga *et al.*, 1999). Considering the importance of the disease, the present investigation was undertaken from *Khariif* 2009 to 2010 to estimate the effect of CLCuD on seed cotton yield and fibre characters in two most popular cultivated Bt-cotton hybrids in Punjab.

Materials and Methods

The studies were undertaken with two Bt-cotton hybrids viz., RCH 134 and MRC 6304 for two consecutive years from *Kharif* 2009 and 2010 seasons at Punjab Agricultural University, Regional Station, Faridkot. The crop was planted under natural epiphytotic conditions with a spacing of 67.5 and 75.0 cm between rows and plants, respectively. Plot size was 500 m² for each hybrid. Fifty plants of each of the following five grades i.e. (i) grade 1 plants with small veinlets thickening (SVT) (ii) grade 2 plants with vein thickening, curling, cupping (iii) grade 3 plants with main vein thickening with enations (iv) grade 4 plants with stunted leafy enations on lower surface of leaf and (v) grade 5 plants having mixed plants of all the grades, were tagged. The healthy plants were categorized as grade 0 (free from viral infection) and tagged in the month of August. The grading system adopted in the present study was finalized by Cotton Pathologist of All India co-ordinated cotton improvement Project (Anonymous, 2000). Data were recorded on disease index and yield components (number of bolls and their weight) and fibre quality such as 2.5% span length (mm), uniformity (%), fibre strength (g per tex) and micronaire value (g inch⁻¹) at crop maturity. The standard statistical procedure of Cheema and Singh (1984) was utilized to analyze the data.

Results and Discussion

Impact of CLCuD on seed cotton yield components: The pooled data of two years indicated that in Bt-hybrid RCH 134 the number of bolls reduced from 54.7 in healthy plants to 40.8 in CLCuD affected plants having grade 1 symptoms; 33.6 in grade symptoms 2; 24.9 in grade 3 symptoms; 12.3 in grade 4 symptoms and 17.7 in mixed grade symptoms. Similarly, the seed cotton yield decreased from 131.8 g plant⁻¹ in healthy plant to 101.5 g in grade 1; 74.1 g in 2nd grade; 56.4 g in 3rd grade; 26.7 g in grade 4 and 42.5 g in mixed grade. On an average, there was a reduction of 52.7 and 54.2 % in number of bolls and boll weight due to CLCuD infection, respectively (Fig.1 A).

Similar pattern was observed in hybrid MRC 6304, where the number of bolls reduced from 33.9 in healthy plants (grade 0) to 31.1 in CLCuD affected plants having grade 1 symptoms; 22.3 in grade 2 symptoms; 17.3 in grade 3 symptoms; 11.7 in grade 4 symptoms and 24.9 in mixed grade symptoms. Likewise, the seed cotton yield decreased from 133.6 g plant⁻¹ in healthy plant to 120.0 g in grade 1; 83.4 g in grade 2; 63.0 g in grade 3; 40.7 g in grade 4 and 71.1 g in mixed grade. On an average, there was reduction of 46.1% in number of bolls and 43.4 % in boll weight due to CLCuD infection (Fig.1B).

These results are in confirmatory with that of Singh *et al.* (1995), who estimated a reduction in seed cotton

yield per plant from 10.5 to 92.2 % in variety F 846 and 39.9 to 79.7 % in variety Pakistani Narma (Niab 72) due to CLCuD infection. The reduction in yield is associated with number of bolls and boll weight, the disease resulted 33.4 to 72.3 % reduction in number of bolls and boll weight, respectively under different agro-climatic conditions (Mahbub *et al.*, 1995). A reduction of 50.3 % in seed cotton yield and 12.3 % in number of bolls per plant was reported in variety F 846; In variety RST 9, the reduction in seed cotton yield was 32.9 and 22.8% in number of bolls due to CLCuD (Ajmera, 2000). Similarly, Singh *et al.* (2002) reported that CLCuD caused 64.7% reduction in number of bolls along with 49.6 % reduction in boll weight in susceptible variety F 846. Further, Singh (2006) found that there was 50.4 % reduction in number of bolls and 42.9 % in the boll weight of plants due to CLCuD infection in variety F 846.

Impact of CLCuD on quality characters of the fibre: The disease affected the fibre properties in hybrid RCH 134 to some extent. It is evident from the data (Fig. 1A) that 2.5% span length was 29.1 mm in healthy plants, which got reduced to 26.5 mm in diseased plants of grade 1; 26.9 mm in grade 2; 25.4 mm in grade 3; 25.4 mm in grade 4 and 27.0 mm in mixed grade. The average of all grades showed that the 2.5% span length got reduced due to CLCuD by 2.9 mm (from 29.1 to 26.2 mm). On the contrary, the effect of CLCuD on fibre strength was not much clear. The fibre strength was 29.1 g per tex in healthy plants; 27.8 g per tex in grade 1; 26.9 g per tex in grade 2; 26.6 g per tex in grade 3; 25.1 g per tex in grade 4 and 28.4 g per tex in mixed grade. Similar pattern was observed for micronaire value which varied from 5.2 g inch⁻¹ in healthy plant to 5.4-4.9 g inch⁻¹ in diseased plants of different grades. Likewise the CLCuD did not have any significant affect on uniformity of the fibres.

On the contrary, the disease had very little impact on fibre properties in Bt hybrids MRC 6304 (Fig.1B). In comparison to 29.9 mm 2.5 % span length in healthy plant, the diseased plants had 29.5 mm in grade 1; 29.1 mm in grade 2; 30.4 in grade 3; 28.2 grade 4 and 29.8 mm in mixed grade. On average no significant differences were observed for 2.5% span length between healthy (29.6 mm) and diseased plants (29.4 mm). Similarly no significant effect of CLCuD was found for fibre strength, micronaire value and uniformity. The fibre strength varied from 31.0 g per tex in grade 0 to 31.4 in grade 1; 30.1 in grade 2; 29.3 in grade 3; 26.9 in grade 4 and 29.9 g per tex in mixed grade. Likewise, the micronaire value ranged from 4.5 g inch⁻¹ in grade 0 (healthy plants) to 4.2 g inch⁻¹ in grade 1; 4.3 in grade 2; 4.6 in grade 3; 4.1 in grade 4 and 4.5 g inch⁻¹ in mixed grade. On

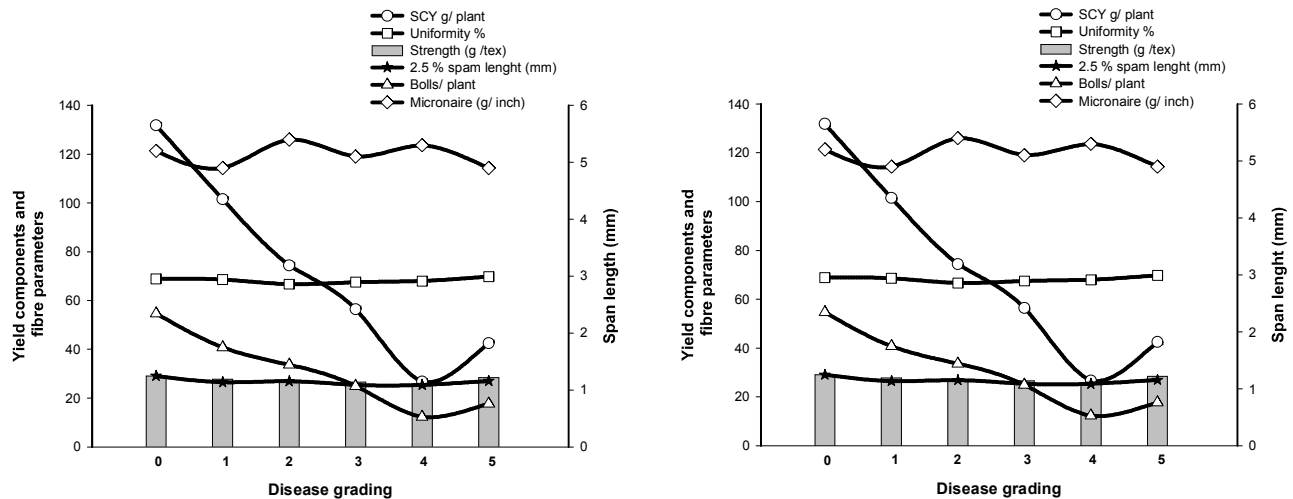


Fig. 1 : Effect of cotton leaf curl disease on seed cotton yield and fibre quality for 2 years of Bt cotton hybrids (A) RCH 134 and (B) MRC 6304; The data is average of two years (2009 and 2010) studies. A. Yield and fibre quality parameters of RCH 134 Bt: number of bolls among different disease grading vary significantly (LSD=0.5); the seed cotton yield vary significantly among the different level of disease incidence (LSD= 25.3). B. Yield and fibre quality parameters of MRC 6304 Bt: number of bolls and different disease grading vary significantly (LSD=5.9); the seed cotton yield vary significantly among the different level of disease incidence (LSD= N.S). The parameters SCY (seed cotton yield), Uniformity, Strength, Span length and bolls/ plant are represented on left Y-axis and Micronaire is represented on right Y-axis. X-axis represents the disease grading grade 0: no disease symptoms; grade 1: vein thickening in top 3-4 leaves only; grade 2: vein thickening, curling and cupping of leaves restricted to 1/3rd plant part; grade 3: vein thickening, curling and cupping of leaves with one to many leafy enations affecting 2/3rd plant part; and grade 4: vein thickening coupled with curling and cupping of leaves, one to many leafy enations, stunting of plants with no or very less boll setting

an average the CLCuD decreased the fibre strength by 4.8 and micronaire by 4.4 %.

Mahbub Ali *et al.* (1995) reported that due to CLCuD, the ginning out turn was reduced by 3.8 %, seed index by 17.3 %, fibre length by 3.9 %, strength by 1.0 % and elongation up to 10.0 %. Monga *et al.* (1999) found a reduction of 14.4 % in 2.5% span length, whereas micronaire value increased to 5.8 g inch⁻¹ in CLCuD infected plant as compared to healthy plants. In a study conducted by Ajmera (2000), the disease reduced the fibre length by 2.6 % in RST 9 and 3.5 % in F 846, whereas strength reduced by 3.4 and 6.1%, respectively. The increase in micronaire value was 2.2 % in RST 9 and 1.2 % in F 846. The present results almost support both the studies where CLCuD affect the yield and quality parameters of two Bt cotton hybrids, however the increase in micronaire value is in contradiction. Singh *et al.*, (2002) reported that CLCuD remarkably deteriorated the quality of fibre in upland cotton i.e. fibre length reduced by 2.9 %, elongation by 13.0 %, uniformity by 1.6 % and micronaire value by 6.3 % in diseased plants having grade 1, 2, 3 and 4 symptom of disease over the grade 0 (healthy plants). In another study, Singh (2006) observed that CLCuD reduced the fibre length by 5.2 %, strength by 5.4 %, elongation by 10.0 %, uniformity by 2.2 % and micronaire value by 4.1 % in diseased plants over the grade 0 (healthy) plants in variety F 846. Thus, the studies of Singh *et al.* (2002) and (2006) corroborate our present findings of reduction in micronaire value due to CLCuD infection. However, the

exact association of micronaire with CLCuD remains unclear and needs further investigation based on physiological studies. The distribution pattern of cotton leaf curl disease (CLCuD) within a particular field clearly suggests its erratic nature. Besides, the doublets analysis also showed that the disease spread by viruliferous whitefly within a field in a non-random distribution pattern (Singh *et al.*, 2004). Thus indicating that it is not necessary that two adjacent plants may be diseased or free from the disease. The results of our study clearly indicated that the disease has significant effect on seed cotton yield and its component such as boll number and boll weight in Bt cotton.

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