Role of early maturing and Cotton Leaf Curl Virus resistant cotton varieties in sustainable cotton production

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ABSTRACT

For efficient and sustainable agriculture production, it will be essential to change over from a commodity-centered approach to farming system's approach. This will call for multi-disciplinary efforts. Further to the challenge is not only to offer solution to raise production but to offer the solution within a time frame. This paradigm shift will call for designing new production system aligned fully with carrying capacity of natural resources endemic to the region. Short season cotton has been grown experimentally successfully for the last few years in India. Short season cotton management is a challenge to both producers and breeders trying to maximize yields. Early development of strong plants, good setting of first flower flush, big bolls combined with adequate management to terminate growth at a desirable stage to ensure good maturation and picking were the main reasons for the high yield in North India. At AR, S Sriganganagar RS-875, a high yielding early maturing variety (150-160 days) has been developed by hybridization and the pedigree selection method. Cotton Leaf Curl Virus *(CLCuV) disease has threatened the cotton cultivation in North India. All dominating cultivated cotton varieties have shown susceptibility to CLCuV and losses assessed due to this devastating disease is even up to 50% reduction in seed cotton yield. To sustain cotton production in North India development of early maturing, high yielding and CLCuV resistant varieties like RS-875, RS-810 and RS-2013 is recommended.*

Introduction

The development and cultivation of varieties with high yield potential and superior production technology have been mainly responsible for increases in production. The genetic modification of the cotton plant into short duration variety of 180-190 days duration is the most significant development in the north India, leading to large scale "cotton–wheat" double cropping. Evaluation of short duration varieties like Ganganager Ageti, Bikaneri Narma, RST-9, F414, F505 have paved the way for such a situation and enabled the farmers to harvest an additional crop of 30-35 q/ha wheat. It is due to this genetic transformation of the varieties of cotton and not of wheat that cotton wheat rotation has become very popular and practically whole is of North India is under this cropping system. Romahlo(1994) states that short duration (145 days maturity) cultivars are very useful in Brazil.

In North India CLCuV has threatened the cotton production. Development of resistant varieties is the cheapest and surest way of combating the disease, which does not require any efforts on the part of farmers. Research efforts to develop CLCuV resistant cotton varieties are under taken in North India at Agricultural Research Station (Rajasthan Agricultural University) Sriganganagar. Efforts have resulted in developing resistant varieties like RS-875, RS-810 and RS-2013 to sustain cotton production.

Cotton Leaf Curl Virus resistance breeding program

With a view to breed early maturing and CLCuV resistant varieties, a large number of crosses were attempted involving resistant cultivar having CLCuV resistance. The desirable crosses were advanced and pedigree selection was made in segregating populations. Elite cultures in F_6 generations were evaluated along with check variety RS-875. The cross F520 x (LH511 x Bombesa)-3 designated as RS-2013 recorded the highest yield. Apart from high yield potential (Table 1), this line demonstrated multiple resistances, that is, resistance for white fly and boll-worm also. The quality characters of the variety RS-2013 are presented in Table 2. This variety has a marker trait for petal colour (yellow) which is a desirable trait for seed production programs and has also shown resistance to CLCuV.

Genetic and varietal resistance

Genetic resistance To combat pests and diseases, integrated pest management of which genetic resistance is a very crucial component, will require emphasis. Improved genetic resistance in the seed is a cheap and effective way, is ecofriendly and does not require any effort on the part of farmer. Screening for resistance to insects and diseases must be initiated during early segregating generations. There is also need to evaluate diverse germplasm including that from related species and incorporate desirable traits into breeding program.

Inheritance of CLCuV More than one gene is involved with interallelic interaction. The modifiers play an important role in genetic control of CLCuV. The results indicate that many Qtl are involved in the genetics of CLCuV. Based on these results, a breeding strategy aimed at pyramiding of Qtl is recommended for breeding resistance varieties for CLCuV. Knight (1954b) has also found that resistance to this disease depends on large number of genes with very small individual effects.

Status of CLCuV in north India CLCuV of cotton is caused by a Gemini virus. In India the disease was first noticed at IARI, New Delhi on the collections of *G. barbadense*. In 1993, disease was observed on *G. hirsutum* near Sriganganagar in Rajasthan (Ajmera, 1994). The disease was also observed in the states Punjab and Haryana in 1994. Incidence of leaf curl disease of cotton in different varieties of cotton grown

in North India is presented in Table 3. CLCuV is the most devastating disease leading to heavy losses and threatens cotton cultivation in North India. The disease has been found to effect size and number of bolls, seed cotton yield, height per plant,2.5% span length, micronaire value etc., when compared with healthy plants. Estimation of losses due to leaf curl disease in cotton is presented in Table 4 and Table 5.

Strategies for management of CLCuV disease

- Regular survey should be under taken to monitor the spread and intensity of the disease.
- Entire belt should grow *G. arboreum* cotton.
- Ban cultivation of susceptible varieties.
- Growing of *G. arboreum* or non cotton crop to from a buffer zone is suggested.
- Regular insecticidal sprays should be given to control white fly.

Conclusion

Shortening of the growing season can provide increase profit. Early development of strong plants, good setting of first flower flush, big boll combined with adequate management to terminate growth at a desirable stage to ensure good maturation and picking were the main reasons for the high yield in North India. Variety Rs-875 contributed the first break through maturing in 150-160 days yielding up to 22-24 q/ha having resistance to CLCuV disease. Research efforts to develop leaf curl virus resistant varieties are being undertaken in North India at Agricultural Research Station Sriganganagar (Rajasthan .Agricultural University.) Research efforts have resulted in developing a number resistant genotype, viz. RS-875, RS-810, RS-2013 and RS992, which has help sustain cotton production in North India.

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Table 1. *Yield performance of RS-2013 from 1995-1999.*

Year	Trial [1]	Average seed cotton yield (kg/ha)	
		RS-2013	Local check
1995-1999	Research (26)	1906	1771
1999-2000	Adaptive (7)	1977	1368

[1]Figures in the parenthesis indicate number of locations.

Table 2. *Quality of fiber (Report through CIRCOT; Mumbai).*

Location	Sriganganagar	Sriganganagar	
Variety	RS-2013	RST-9	RS-875
Store No.	000691	000696	000700
2.5% Span length(mm)	24.6	23.6	27.8
Micronaire value	4.5	5.8	5.0
Uniformity Ratio	52	50	52
Fiber Maturity%	81	84	86
Bundle Strength	21.1	18.6	21.6
Full Spinning	2486(20s)	2078(16s)	2256(20s)
(CSP)	2292(30s)	1904(20s)	1950(30s)

Table 3. *Incidence of CLCuV in different varieties of cotton grown in North India.*

Species	Varieties	State	Maximum disease incidence (%)			
			1994	1995	1996	1997
G. hirsutum	RST-9	Rajasthan	95	90	70	80
	F846	Punjab	90	80	50	80
	LH-900	Punjab	80	60	40	70
	HS-6	Haryana	50	20	20	70
	F-1054	Punjab	60	5	-	10
	Ganganagar Ageti	Rajasthan	5	5	5	50
	Bikaneri Narma	Rajasthan	10	5	5	15
	Maruvakas hybrid	Rajasthan		10	10	60
	Fateh(hybrid)	Punjab		10	10	70
	Dhan Laxmi	Haryana		10	8	60
	RS-875	Rajasthan		0	0	0
	LHH-144(Hybrid)	Punjab		0	0	0
	Pakistani Narma		95	90	80	80
G. arboreum	RG-8	Rajasthan	0	0	0	0
	HD-107	Haryana	-	0	0	0

Table 4. *Estimation of losses due to CLCuV in cotton.*

Variety/Place	Height (cm)	Percent reduction/plant		Seed cotton yield (g)
		No. harvestable bolls	Boll weight (g)	
Sriganganagar (Raj.)				
(a) F-846	16.1	50.3	12.3	50.3
(b) RST-9	3.5	22.7	0.00	32.9
PAU-Ludhiana				
(a) F-846	---	14.9-87.4	38.8	10.5-92.2
(b) Pakistani Narma (NIAB-72)	---	30.7-68.6	11.9-40.5	39.9-79.7

Table 5. *Qualitative estimation of losses due to CLCuV in cotton.*

Variety	Year	Percent Reduction / increase		
		2.5 % span length (mm)	Micronaire value	Bundle strength 'O' gauge
RST-9	1995	1.2	0.5	2.3
	1996	2.0	4.0	4.5
F-846	1995	1.2	0.3	3.6
	1996	5.9	2.2	8.7