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DEVELOPMENT OF ADVANCED COTTON MUTANT LINES RESISTANT TO CLCuV DISEASE, HIGH YEILDING WITH SUPERIOR FIBRE QUALITY TRAITS DEVELOPED THROUGH THE USE OF INDUCED MUTATION

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Abstract

Considering the continous persistancy CLCuV disease, fibre quality of present grown commercial cultivars a massive research breeding program aimed producing early maturing, high yielding, CLCuV resistant superior fibre quality mutants was undertaken in the year 1993 / 1994 and have expanded since. Treatment of one locule bulk; F_1 seed derivative of cross between interspecific mutant (ISM) strain NIAB-313 (*Gossypium barbadense* L. x *Gossypium hirsutum* L.) with exotic (Reba P-288) was done at 20, 25 and 30 Kr (Co^{60}) gamma (γ) radiation doses. Radiation treatment at 30 Kr dose proved to be successful for creating valuable genetic variability. Mo seed was used to raise M_1 and subsequent segregating generations for the selection of desirable segregants. Nine promising high yielding superior fibre quality mutant lines (M_6) i.e. N-358/2, N-358/4, N-358/8, N-358/15, N-358/17, N-358/22 and N-358/30 that do not support virus accumulation even upon subjecting to extensive whitefly-mediated inoculation, CLCuV spreader line, and modified bottle shoot grafting.

Introduction

Cotton (*Gossypium hirsutum* L.) C_3 plant, an international agricultural commodity of which the quantity and quality are subject to various whims of nature. Cotton is the country's major cash crop and provides the main stay of the export and manufacturing sector. The economy of Pakistan can be rightly called the mono-commodity because of its exceptional dependence on cotton, providing more than 60% foreign exchange earning. Since 1992/93 occurrence and continuous persistency of CLCuV disease has seriously debacled our cotton production, resulting billions rupee loss to our economy: Cotton leaf curl virus (CLCuV) a name given to a group of gemniviruses transmitted by whitefly, *Bemisia tabaci* Genn. infected the cotton crop in open fields, causing losses upto 100% in the cotton producing areas (Brown and Nelson, 1984 and Brown *et al.* 1987). Though the incidence of this disease has been curtailed to some extent by developing CLCuV resistant varieties, but inoculum is still hovering threat and needs fool proof strategy for eradication of this disease to recover the erratic productivity trend of this vital crop. Presently grown commercial cultivars are although CLCuV resistant but endowing with inadequate ecological plasticity, *i.e.* narrow genetic base limited to regional adaptability, erratic response to environmental stresses (diseases, sensitive to high temperature, insect/pest, inputs applied) and fibre qualities not so suitable to compete consumers preference world wide (Table-1).

Breeding program aimed at producing early maturing high yielding, heat and CLCuV resistant superior fibre quality cotton cultivars was started in 1993/94 and have expanded since. The prime focus of this objective was based on the introduction of resistant/fairly resistant genes found in exotic cultivar Reba-P-288 (other wise bushy plant) to our susceptible, interspecific mutant line NIAB-313/35 (high yielding along with superior fibre quality traits) followed by gamma radiation to create the wealth of

genetic variability and selection of desirable mutants. Because on the basis of law of homologues series by the use of induced mutation one can expect the production of novel type characters that have not previously been known in nature. Several mutant traits, which had never been reported, were able to obtain by induced mutations such as *Verticillium* resistant mutants of pepper mint, golden mosaic virus resistant mutants in dry beans (Thlman-Neto *et al.* 1997).

After 7 years of efforts nine promising stable mutant lines have been obtained. These advanced mutant lines don't support virus accumulation, even upon subjecting to extensive whitefly mediated inoculation, CLCuV spreader lines, and modified bottle shoot grafting (Wilson *et al.* 1989).

Materials and methods

In 1992 and 1993 number of available genotypes/germplasm were screened under the natural prevailing conditions (considering hot spot in respect of CLCuV) to confirm resistance against CLCuV. Among these genotypes screened genotype Reba P-288 (CIRAD, Montpellier, France) exhibited fairly resistance/co-tolerence against CLCuV disease. With a view for the introgession of resistant genes to our susceptible commercial cultivars Reba P-288 was crossed with stable interspecific mutant strain NIAB-313 (high yielding, long staple, CLCuV susceptible) derivative of *G. barbadence X G. hirsutum* L. (Bhardwaj and Weaver, 1984). All hand pollination's was completed before 1200h. Each flower was re-bagged immediately after the hand pollination was completed and remained baged until the following day. Matured open bolls were collected and were examined to determine the number of seeds produced per boll. Mature F_0 seed was used to raise F_1 populations. Plants of F_1^* generations were selfed and subsequently used to raise F_2^* population along with M_1^* populations derived from the irradiation of one locule bulk of F_1 population at 20, 25, 30 Kr gamma radiation doses 30 Kr dose proved to be the successful dose for breaking the undesirable linkages to raise the segregating generations for the selection of desirable segregants. The methodology adopted for the selection of CLCuV resistant desirable segregants / advanced mutant lines at each generation (M_2-M_6^* generation) has been summarized in the flow chart described in Figure-I.

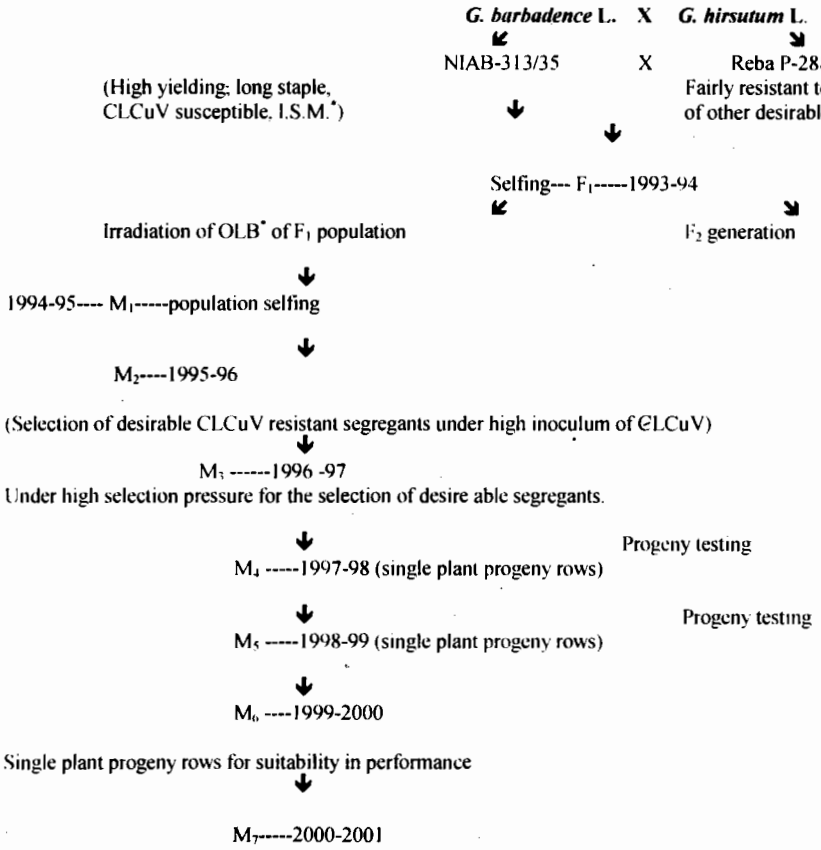
Results and discussion

From a series of crosses between susceptible interspecific mutant (I.S.M) line NIAB-313/35 and Reba P-288 (fairly resistant not highly resistant against CLCuV disease) parents followed by the gamma irradiation of F_1 populations, by selection of desirable segregants, (M_2-M_4) nine promising stable mutant lines (M_6), Co-namely N-358/2, N-358/4, N-358/8, N-358/15, N-358/17, N-358/22 and N-358/30 that don't segregate for resistance against CLCuV have been obtained. Data concerning appearance and severity of CLCuV disease symptoms was recorded for the parents F_1, M_1/F_2 and for different segregating populations/advance mutant lines at different plant developmental growth stages. These lines don't support virus accumulation even upon subjecting to extensive whitefly-mediated inoculation growing alongwith CLCuV spreader lines and modified bottle shoot grafting. These promising advanced CLCuV resistant mutant lines posses desirable morphological traits, squaring/boll retention at 7-8th node, boll weight, high yielding potential along with fibre quality traits (Table 2).

From these results we have concluded that the use of induced mutations has contributed the fact in the production of such novel type characteristics like highly resistant (resistant to CLCuV) from a cross between susceptible and fairly resistant parents that have not been previously reported in nature (Ahsan-ul-Haq *et. al.*, 1983). Because in these studies gamma irradiation has helped us in production of high yielding CLCuV resistant mutant lines, along with superior fibre quality traits. As it has also helped us in the development of early maturing high yielding wider adaptability cotton variety NIAB-78 that revolutined the cotton production in Pakistan and ISM-NIAB-313 by breaking undesirable linkages, pollen antagonism and diversion towards original (when *G. barbadance* was crossed with *Gossypium hirsutum* L.). These advanced mutant lines are being tested in micro, macro and sub preliminary zonal varietal trials in different environmental conditions considering hot spot in respect of CLCuV disease and other environmental stresses before their release as commercial varieties.

* Screening against CLCuV resistance was made by
Inoculation with viroliferous whiteflies.
CLCuV spreader lines.
Modified bottle shoot grafting.

FIGURE-I: Flow chart of methodology adopted for the production of CLCuV resistant advanced mutant lines.



Advanced mutant lines having stability in resistance, early maturing, desirable foliage density, high yielding potential and fine fibre qualities.

Stable advanced mutant lines denominated NIAB-358 are being tested in micro macro, sub-preliminary yield trials.

***Table-1: Fibre characteristics of presently grown cotton varieties.**

Faculty No.	Av.& Range	FIBRE CHARACTERISTICS Length (mm)	Uniformity (%)	Fineness (mg/inch)	Maturity (%)	Strength (TPPSI)	Trashes (%)
1	Av value	26.7	47.4	4.9	1.01	96.5	6.0
	Minimum	25.7	45.6	4.4	0.93	94.7	6.0
	Highest	27.7	49.5	5.3	1.09	99.3	11.3
2	Av value	26.7	47.7	4.8	0.98	96.6	8.8
	Minimum	25.4	46.5	3.8	0.82	92.2	7.2
	Highest	27.9	49.5	5.4	1.10	101.2	10.5
3	Av. value	26.9	47.8	4.9	0.98	96.1	9.3
	Minimum	25.4	45.9	4.3	0.91	92.6	7.5
	Highest	27.9	50.8	5.4	1.05	99.4	11.4
4	Av Value	26.7	47.7	4.9	1.01	96.8	8.7
	Minimum	25.7	46.2	4.6	0.90	91.2	6.7
	Highest	27.7	48.8	5.3	1.09	100.4	10.7

*The Pakistan Cotton grower, October to December, 1999.

Table-2: Characteristics of newly developed CLCuV resistant promising mutant line at NIAB.

Strain	Height (cm)	Sympodial branches (Number)	Response to CLCuV Field/graft	Boll weight(g)	GOT (%)	Fibre characteristics			Yield/acre (kg)
						Length (mm)	Fineness Maturity (µg/Inch)	(%age)	
358/2	119	24	Nil	3.5	36.2	30.3	4.0	109	2715
358/4	109	22	Nil	3.5	38.0	28.8	4.4	109	1736
358/8	108	22.3	Nil	3.72	37.1	29.5	4.12	110	2528
358/15	117	22.5	Nil	3.90	36.6	30.9	3.93	109	2352
358/17	126	25.75	Nil	4.1	35.8	30.5	4.25	110	2356
358/22	107	21.6	Nil	4.8	35.3	30.4	4.33	110	2536
358/30	107	27.22	Nil	3.6	35.9	30.5	4.19	111	2201
CIM-443	138	25.7	Nil	3.0	35.6	26.2	5.40	115	1420
CIM-446	142	27.6	Nil	3.4	35.9	25	5.34	109	1124
FH-900	150	21.5	Nil	3.9	36.3	27.2	4.84	114	1480

G.O.T. : Ginning out turn %age.

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