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DEVELOPMENT OF A HIGH YIELDING COTTON MUTANT, NIAB-92 THROUGH THE USE OF INDUCED MUTATIONS

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Abstract

Soaked seeds of an exotic variety Stoneville-231 (*Gossypium hirsutum* L.) were treated with gamma-rays at 30 kR from ^{60}CO source having dose rate of 40 kR per hour and planted in the field as M_1 generation during 1984. From the segregating generations, a high yielding mutant was selected and named as NIAB-92. The plant of NIAB-92 is a semi-hairy, compact sympodial type of medium stature. It has 0-2 fruit bearing monopodial branches and more number of shorter sympodial branches as compared to the parent, Stoneville-231 and commercial cotton variety NIAB-78. The mutant is early maturing and matures twenty days earlier than the parent Stoneville-231. It has higher yield potential alongwith desirable fibre properties such as G.O.T.(%), fibre length, fibre fineness and fibre strength. In the comparative yield trials the mutant NIAB-92 significantly outyielded both the prevalent commercial cotton varieties i.e., NIAB-78 and S-12. At NIAB it gave 15.3 % and 19.1 % higher yield than NIAB-78 and S-12, respectively, while at farmers fields the increase in yield was 8.8 % and 14.1 % as compared with NIAB-78 and S-12. The mutant has also shown resistance against leaf curl virus disease.

Introduction

Cotton is the most important crop of Pakistan, however the cotton yield per hectare has been somewhat lower than many other cotton growing countries of the world (ICAC, 1992). Although the improvement of cotton through conventional plant breeding approach is still the most widely used method but the availability of a desirable variablity is pre-requisite for useful crossbreeding programmes. If the particular trait is not available among existing cultivars then the crossbreeding may not be successful. The use of induced mutation is a suitable technique for further cotton improvement. In recent years induced mutations has played a greater role for the improvement of crop plants. Using this new approach a large number of early, high yielding, high protein, disease and insect resistant varieties of various crops i.e., wheat, barley, rice, cotton, maize etc. have been released in different countries (Micke et al., 1987). Al-Didi (1965) obtained three improved mutants of Egyptian cotton following irradiation of seed at 555 Rads of gamma-rays from ^{137}Cs radiation source. Nazirov & Perespenko (1966) treated hybrid cotton seed with gamma-rays and were able to break linkage between earliness and boll size. Carnelius (1973) developed a new cotton variety MCU-7 which is early, high yielding and has a longer staple than its parent. Raut *et al.*, (1973) have reported a photoperiodic insensitive cotton mutant which flowers in 55-60 days. Shuaib *et al.*, (1981) isolated two mutants from a population derived from 20 kR of gamma-rays treatment. Khan *et al.*, (1982) reported that local variety AC-134 was the most radio-resistant while the exotic material i.e., Stoneville 7A and Stoneville 15-17 was the most radio-sensitive. Iqbal *et al.*, (1991) while reviewing the economic and agricultural impact of mutation breeding in cotton in Pakistan, reported the development of a high yielding, early maturing mutant NIAB-

Table 1. Morphological characteristics and fruiting pattern of mutant NIAB-92 compared with some other varieties.

Mutant/ Variety	Height of main stem (cm)	Length of internode (cm)	No. of monopa-dia/plant	First sympodial node(No)	No. of sympodia/ plant	Length of 10th sym-podial (cm)	Grade of hairiness	Abscission (%)	Days to maturity	Total fruiting points/(m^2)	Intact bolls/m^2
NIAB-92	155.3a	4.5b	0-2	9.5b	27.3a	31.7c	5.5a	54b	155b	745b	342a
NIAB-78 (Standard)	134.4b	4.3c	0-1	9.3b	22.2b	49.3a	5.5a	56b	145b	601c	264b
*Stoneville-231 (Parent)	160.0a	6.0a	0-3	10.5a	20.0b	40.0b	0.5b	80a	175a	825a	165c

Means followed by different letters in the same column differ significantly as determined by DMR Test.

*An exotic variety which is non-adaptive to local climatic conditions.

78 by irradiating the F_1 hybrid (Deltapine x AC-134) seed at 30 kR of gamma-rays. The objectives of the present study were to create useful genetic variability for developing high yielding cotton varieties and desirable germplasm.

Materials and Methods

Stoneville-231 (*G.hirsutum* L.) has been used as a parental material in these studies. It is an exotic cotton variety from USA. It has longer mainstem/sympodia internodes and less yield (Pakistan) but the Stoneville material was found more suitable for irradiation (Iqbal *et al*., 1982). One thousand non-delinted seeds of an exotic cotton variety Stoneville-231 (*G.hirsutum* L.) were soaked in water for two hours and then exposed to gamma-rays at 30 kR from ^{60}Co radiation source having dose rate of 40 kR per h. The treated seeds were planted in the field as M_1 generation during 1984. At maturity 5 seeds per boll were collected from each M_1 plant to raise M_2 population. The M_2 population comprised of about 12555 plants grown at a spacing of 45 cm x 75 cm. From the M_2 population the selections were made on the basis of earliness, better plant type, better yield components and desirable fibre properties. The seeds of 45 selected M_2 plants were sown as M_3 generation in replicated progeny test (RPT) with 3 replications. The size of the individual plot was 0.75 m x 10 m. The breeding behaviour of these progenies was determined. The progenies were of varied nature and some of these possessed certain desirable combinations of plant type, hairiness, earliness and good boll bearing. From the M_3 generation, 6 plants of the best family (B-97) were selected and studied as M_4 generation as RPT to determine the uniformity for plant type, and other morphological traits. Better yielding plant progenies were selected and studied as M_5 generation. In M_5 generation, the selected line (B-97) bred true-to-type for earliness, medium plant height and other desirable characteristics. It was studied in M_6 for evaluation and confirmation. On the basis of persistent behaviour for all the characteristics during M_6 generation the mutant was bulked and named as NIAB-92. The mutant was extensively evaluated in yield trials conducted at NIAB and farmers fields as compared with the prevalent standard cotton varieties i.e., NIAB-78 and S-12. The trials were laid out in a randomized complete block design having plot size of 3.8 m x 11 m with three replications. At farmers fields the mutant was tested in zonal varietal trials at 10 different locations in the districts of Vehari, Khanewal, Multan, Toba Tek Singh, Faisalabad and Jhang during 1991-92. The standard plant protection measures to control the attack of sucking insects and bollworms were adopted throughout the crop season in all the experiments. The data for various morphological characteristics, fruiting pattern, earliness, seed cotton yield and fibre properties were recorded and statistically analysed (Steel & Torrie, 1980).

Results and Discussion

The results on morphological characteristics and fruiting pattern (Table 1) showed that the plant of mutant NIAB-92 is semihairy, has medium height and medium inter-nodal length but shorter sympodial branches as compared to parent (Stoneville-231) and a high yielding commercial variety NIAB-78. Mutant NIAB-92 matures 20 days earlier as compared to parent i.e., Stoneville-231 while a little late

Table 2. Comparative yield performance and fibre characteristics of mutant NIAB-92 and other commercial cotton varieties at NIAB during 1990-91.

Mutant/ variety	Yield (kg/ha)	% increase (+) over	G.O.T. (%)	Fibre length (mm)	Fibre fineness (Ug/inch	Fibre strength (000 Psi)
NIAB-92	4723a	---	38.0a	27.2a	4.5a	90.4a
NIAB-78	4095b	15.3	36.2b	27.1a	4.5a	89.0a
S-12	3963c	19.1	39.0a	27.5a	5.0a	85.7b

Means followed by different letters in the same column differ significantly as determined by DMR Test.

than NIAB-78. The results presented in Table 1 indicate that the mutant NIAB-92 has a medium hairiness grade (5.5) which helps in reducing the attack of jassid as well as white fly, the major sucking insects of cotton. Moreover due to its early maturity (Table 1) it can escape the peak period of spotted and pink bollworms attack and hence can delay the entry of late brood larvae into diapause, a carry over source of infestation for the next year (Iqbal *et al.*, 1991). Mutant NIAB-92 has significantly less total number of fruiting points but significantly more intact bolls per unit area as com-

Table 3. Yield performance of mutant NIAB-92 compared with commercial varieties at farmers fields during 1991-92.

S.No.	Locations	Yield(kg)/ha		
		NIAB-92	NIAB-78	S-12
1.	Faisalabad Site-I	5323 a	4932 ab	4564 b
2.	Faisalabad Site-II	5503 a	5157 ab	4972 b
3.	Toba Tek Singh	5491 a	4759 b	4653 b
4.	Jhang	5515 a	4989 b	4571 b
5.	Khanewal Site-I	5716 a	5024 b	4927 b
6.	Khanewal Site-II	5612 a	5199 a	4851 a
7.	Vehari Site-I	5414 a	5100 a	5011 a
8.	Vehari Site-II	5449 a	5140 ab	4831 ab
9.	Multan Site-I	5506 a	5056 ab	4895 b
10.	Multan Site-II	5543 a	5261 ab	4992 b
Average		5507 a	5062 b	4827 b

Means followed by different letters in the same column differ significantly as determined by DMR Test.

Table 4. Fibre characteristics of Mutant NIAB-92, compared with commercial varieties at farmers fields during 1991-92 (Average of 10 locations).

Mutant/ variety	G.O.T. (%)	Fibre length (mm)	Fibre fineness (Ug/inch)	Fibre strength (000 Psi)	Fibre maturity (%)
NIAB-92	38.4a	27.7a	4.6a	91.7a	82.2a
NIAB-78	36.2a	27.1a	4.5a	86.0c	82.2a
S-12	39.3a	27.5a	4.5a	89.5b	81.1a

Means followed by different letters in the same column differ significantly as determined by DMR Test.

pared to the parent as well commercial variety NIAB-78 (Table 1). No doubt the parent Stoneville-231 has more fruiting points (825) than the mutant (745), but has less bolls (165/m^2) as compared to the mutant (342/m^2). It may be due to the genetic change/mutation, having higher potential for boll formation. Moreover the shorter internodes and more height of mutant NIAB-92 helps to produce more number of compact fruit bearing (sympodial) branches, resulting in more number of bolls per unit area. Similar results have already been reported by Raut *et al.*, (1973) Micke *et al.*, (1987), and Iqbal *et al.*, (1991).

The results for higher yielding ability and quality characters of NIAB-92 are presented in Table 2-4. At NIAB, the mutant NIAB-92 significantly outyielded both the standard varieties i.e., NIAB-78 and S-12. It gave 15.3% and 19.1% higher yield as

Table 5. Response of cotton varieties planted at PSC Farm, Khanewal to leaf curl virus disease (1991-92)

Varieties	Disease incidence (%)	Reaction	Grade
S-12	100	HS	9
CIM-70	100	HS	9
MNH-93	20	MS	5
NIAB-78	80	HS	8-9
NH-26	100	HS	9
NIAB-92	5	R	1-2
FH-87	30-40	MR	4-5

Source: Cotton leaf curl disease report by Ayub Agricultural Research Institute, Faisalabad.

HS = Highly susceptable, MS = Moderately susceptable, MR = Moderately resistant, R = Resistant compared to NIAB-78 and S-12 respectively. Mutant NIAB-92 has better ginning out-turn (%) than NIAB-78 while other fibre qualities are comparable to commercial varieties, however mutant NIAB-92 has better strength than S-12. The results of the mutant NIAB-92 obtained in farmers fields during 1991-92 illustrated higher yield potential and gave significantly higher mean yield (Table 3). Moreover the quality characters i.e. G.O.T.(%), staple length, fibre fineness and fibre maturity were at par with the commercial standard varieties except its higher strength (Table 4). These results confirmed the findings already reported by AL-Didi (1965), Carnelius (1973), Micke *et al.*, (1987) and Iqbal *et al.*, (1991). Moreover, the mutant NIAB-92 in a comparative study showed genetic resistance against leaf curl virus disease (Table 5). The mutant got the minimum disease incidence i.e., 5% while the disease incidence in other varieties was much higher and ranged from 20-100 %. Induction of disease resistance through induced mutations has also been reported by Micke *et al.*, (1987).

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