CHAPTER 8
SUMMARY

Summary of the research investigation is narrated in two parts;

1) A brief summary of results and conclusions.
2) Practical Utility.

(The first part briefly illustrates the results & conclusions and second part is of practical utility)

The present study was aimed at elucidating information on the effect and effectiveness of physical and chemical mutagens in relation with genetical improvement mainly for fibre properties and few economically important characters. Besides, it was intended to understand the impact of various mutagens on variability, stability, recombinations and correlation parameters.

Promising G. arboreum strain NA-39 was treated with different doses of Gamma-Ray (15KR, 20KR & 30KR) at the rate of 7KR/minute by $\gamma$Co$^{60}$ source and 0.2% EMS for 24 hours before sowing with water soaked seeds. The observations on mutagenic effects in M1 generation revealed an adverse effect on seed germination, survival, seedling growth and pollen fertility. In general, there was dose dependent reduction. Mortality percent was higher with 30kr dose followed by 0.2% Ems, 20kr and 15kr. In general mutagene damage was more pronounced in irradiated population compared to EMS treated population.

Observed morphological changes were screened for divergent plant characters and qualitative & quantitative parameters for growing further generations. Screened lint
samples from M2 to M5 generations were analysed for important fibre quality parameters, like mean fibre length (MFL), fineness, maturity coefficient (Mc) and fibre tenacity.

Finally 91 derivatives were screened in M5 generation for detailed fibre quality studies, like mature fibre percentage (NaOH, microscopic method), fibre tenacity at '0', '1/8' and '1/4' gauge length with elongation percentage and uniformity ratio, toughness, stiffness in addition to measurement of convolutions, convolution angle, reversals and fibre diameter (microscopic method).

Fibre orientation was studied by x-ray diffraction and fibre crystallinity measured by infrared spectroscopic method. Interrelationship between fibre structure and fibre properties have been established.

A novel method was developed to measure the convolution angle based on Fraunhoffer diffraction principle which is well known to physicists but was introduced for the first time to cotton scientists. Non destructive diffraction method was also developed to measure the fibre diameter with the use of laser beam, which is very accurate and quick as compared to traditional microscopic method.

In addition to above quality studies, detailed field observations and economical parameters were studied like yield, boll weight, ginning outturn and seed index.

Data has been statistically analysed and mean, range, coefficient of variation, genetic advance, stability and heritability were calculated. From genetic correlation studies, efficacy of each treatment in breaking the undesirable linkage and raising the intensity of desirable association. The successful performance of mutant depends on the
beneficial mutations.

1. The mean performance of four population at end of W5 was in general higher than the control for all the characters except for maturity % (30KR & 0.2%EMS), T1 (1/8 gauge fibre strength) (15KR), Toughness (15KR) and (20KR) Amongst the four treatments, deleterious effects were pronounced in 30KR for all characters except for mean fibre length (MFL).

2. Range of variability was wider with 15KR for mean fibre length (MFL), E1 (elongation at 1/8 gauge) and stiffness; 20KR for strength T0, T1, T2 (bundle strength at '0', '1/8' & '1/4') and ginning outturn (GOT); 0.2%EMS for torvehness and yield characters. Treatment 30KR proved effective in generating wider range of variability for fineness, M% (mature fibre percentage) E2 (elongation at '1/4' gauge), ginning outturn (GOT), boll weight (B.W) and seed Index (SI).

3. Percentage of derivatives showing superiority over control was maximum for charactrs viz mean fibre length (MFL) (20%), (T1) bundle strength at 1/8 gauge (28%), E1 (elongation at 1/8 gauge) (50%), Toughness (36%), stiffness (36%), ginning outturn (GOT) 28% in 15KR. Treatment 30KR proved effective for the characters viz fineness (48%), maturity percent (35%) strength (32%), T2, (32%) and yield (32%) and for two characters viz E2 (52%) & seed Index (23%). On the basis of over all mean, 0.2% EMS for seed cotton yield, 15KR for mean fibre length (MFL) and ginning outturn (GOT) exhibited significant improvement over the check and was to the extent of 20.5%, 3.9%, 6.2% respectively. Treatment 15KR and 30KR developed 66% and 43% strains respectively which recorded significant superiority
over control for mean fibre length (MFL) and ginning outturn.

4. Heritability and G.A estimates were the highest for seed cotton yield in the 0.2%EMS dose and for GOT in the 20KR population. Positive relationship among mean, heritability and genetic advance (G.A) was observed with 15kr dose for fineness, mature fibre percentage (MF%) stiffness in 30KR dose for strength T2, elongation E2, seed index (S.I.) and 20KR dose for ginning outturn (GOT) and Boll wt. while such trend was not evident with mean fibre length (MFL), strength at 1/6 gauge (T1), elongation (E1 and E2), toughness characters.

From all these observations, it can be concluded that, mutagenes used in present investigation behaved differently in improving various characters. It can be seen that 0.2% EMS showed maximum improvement in seed cotton yield. Significant improvement in fibre strength & fineness was exhibited by 30KR and 15KR dose respectively. Thus it appears that 15kr exhibited relatively higher efficacy over rest of the treatments in inducing recombinations for longer MFL either with higher yield or higher ginning outturn (GOT) and GOT with yield because 15KR treatment resulted in developing 52% and 57% of the total strains which exhibited significant improvement for combination of those characters over control NA-39.

The chances for isolating the strains having combination of higher seed cotton yield coupled with increased ginning outturn (GOT), longer fibre length, good fibre strength and desirable micronative (fineness) were maximum in the 15KR dose. This treatment developed 4
strains viz. mutant no. 2, 5, 6 and 10 which recorded significantly superior performance over control for these four characters.

**Correlation and recombination**

5. In control population, MFL showed negative correlation with strength, maturity, ginning outturn (GOT) and seed cotton yield. However, a shift in the trend from negative to positive either significant or non-significant was evident with mutagen population. Treatment 20KR proved effective in mutating genes, thereby, resulted in showing strong positive association between mean fibre length (MFL) with fibre strength & ginning outturn (GOT).

Treatment 20KR becomes worth to adopt as its effect resulted in reversing the trend from negative to positive for MFL with seed cotton yield. Recombination studies supported the above findings. Application of selection pressure in the population of 20KR for mean fibre length (MFL) will not necessary to affect the other characters like ginning outturn (GOT) and seed cotton yield. Hence chances for simultaneous improvement of MFL with GOT or yield is possible. No such desirable trend was observed in rest of the treatments.

Fibre strength exhibited very strong negative correlation with fineness in control and 20KR while in rest of the treatments, it was positive but intensity was either strong or weak. Such desirable trend obsedved in former treatments have a practical bearing and it will be possible to evolve a long staple variety having appreciable fibre strength. Mention of strain No. 21, 23, 27 (20KR) and strain No 42, 54, 57 (30KR dose) are worth as these strains
recorded mean fibre length (MFL) above 25mm coupled with fibre strength in the range of 54.1 to 58.4 (g/tex). Likewise, between MFL and fineness strain NO.2, 5, 6, 10 of (15KR); 18, 22 of (20KR); 39, 42, 54, 57, 61 & 75 for (30KR) and strain No. 89 of 0.2%EMS showed promise for combination of characters. Peformance of strain No. 20, 35 of (20KR) and strain No. 42, 53, 54, 57, 69, 74 of (30KR) for combination of strength and fineness worth to note.

The absence of negative linkage between fibre length with ginning outturn (GOT) and mean fibre length (MFL) MFL with yields indicated that fibre length can be increased without increasing declining seed cotton yield or ginning outturn (GOT) or thus, the present investigation revealed that mutagens had considerable effect on genotypic correlations. The observations on correlations are coincided with recombination parameters.

Efficacy of mutagen was also evaluated using correlation and recombination parameters. Results revealed that the effect of 20KR treatment in the desired direction for mean fibre length with micronaire value and Maturity co-efficient. Both of these mutagens also had effect in desired direction for the mean fibre length with T0, T1, and T2. (Bundle Strength at '0', '1/8' and '1/4' gauge length.). Neigher 15KR nor 0.2% EMS showed ability to change the direction of association from significant negative to either non significant positive or significant positive.

Line No. 9, 10, 47 & 36 evolved by using 30kr treatment are worth to mention as they may express fibre length even up to 28mm under favourable conditions.
Likewise, 0.2%EMS also stimulated effect in desired direction for combinations of characters like mean fibre length (MFL), maturity coefficient (MC), fibre bundle strength, fineness. Line No.30, a derivative of 0.2%EMS was worth to mention from above point of view. Crossing amongst such selected elite lines may help to evolve a genotype having desirable levels for most of the characters. Either interse or biparental crossing may prove rewarding.

Superior performance of these lines, testing on large scale may result in evolving *G. arboreum* variety having character combinations of negative correlated. Such desi strains may show spinnability at par with any *G. hirsutum* cotton. Moreover, biparental crossing amongst these elite lines may result in evolving a strain with all desired combinations.

6. Extent of regression effect observed at end of M5 generation. Mutagen 0.2%EMS and mean fibre length (MFL), maturity coefficient (Mc), ginning outturn (GOT), (15KR) for fineness, fibre strength, seed index and seed cotton yield showed maximum effect of regression phenomenon. Hence even though, these mutagens for respective characters in early generation though showed improvement, they have less practical utility as population at end of M5 generation showed tendency to revert to original population level.

On the contrary, treatment 15KR for mean fibre length (MFL), ginning outturn (GOT), 0.2%EMS for fineness, yield, 20KR for maturity coefficient, fibre strength did not show regression effect and hence worth to adopt in crop improvement programme.
Percentage of genotypes significantly less over population mean was minimum in 0.2%EMS for mean fibre length (MFL), fineness, E1, E2 (elongation), maturity coefficient (Mc), seed index (SI), toughness, stiffness and seed cotton yield. These results indicated effectiveness of 0.2%EMS in preventing and minimizing regression effect. Generally, mutagenic population have a tendency to express regression behaviour. In this context, chemical mutagen 0.2% EMS had an edge over that if breeder desires to have minimum regression, use of 0.2% EMS will be an appropriate.

Chances of evolving genotypes with below average stability is more with 20KR as it generate maximum genotypes of below average stability with higher performance for fineness.

7. Stability parameter :-

Vis-a-vis efficacy of four mutagenes was also studied by using stability parameters. Scrunity of data indicated relatively higher efficacy of either 0.2%EMS or physical mutagene 20KR dose. With maximum proportion characterized by bi=1.0 and mean significantly higher over population mean and control for mean fibre length (MFL) and strength respectively.

PRACTICAL UTILITY

1. Cotton breeding programme claims at evolving strains with high yield potential and improved fibre qualities. However without knowledge of fibre structure, it is rarely possible to achieve the aim. Hence it was intended to understand the impact of mutagens on fibre structure and their effect on fibre properties as well as on yield & yield components. Varietal evolution policy for cotton is to evolve
a variety which gives at least 20% higher seed cotton yield
or 2mm longer fibre length & 2% higher ginning outturn (GOT)
over the popular variety under cultivation. It is, therefore,
necessary to review the results of the present
investigation for practical utility from above point.

The efficiency and effect of physical and chemical
mutagens was evaluated by studying the various genetical
parameters. The present results, based on various parameters
revealed that fibre length and other fibre properties may be
improved significantly by adopting 0.2%EMS or 15KR Gamma-Ray
dose. Various parameters further revealed that with the
adoption of 20KR dose, chances for improving ginning outturn
(GOT) are more, polygenic characters, largely influenced by
the environment is the seed cotton yield. With the adoption
of 0.2%EMS dose population yield can be improved to great
extent. Certain derivatives of 0.2% EMS dose recorded double
increase in yield over control (NA-39) as well as over
adopted variety Eknath.

2. Induction of new recombinations and breaking of
tightly linked associations amongst economically important
characters viz. yield, ginning outturn (GOT) & mean fibre
length (MFL) may be achieved effectively by adopting 15KR
Gamma-Ray dose. This is evident as 50% derivatives of 15KR
treatment recorded significantly higher performance for fibre
length with seed cotton yield and ginning outturn (GOT) as
well as yield. Correlation values estimated in each
population strongly support that this treatment has ability
to induce recombinations either to break or reduce the
intensity of the association. However, 30KR treatment
resulted in giving significant positive association between
mean fibre length (MFL) & ginning outturn (GOT) r=(0.47).

Genetic variability present at the end of fifth generation enlighten that there is ample scope for further genetical improvement in most of the characters in population of 0.2% EMS. High mean associated with higher magnitude of heritability and genetic advance have been observed in the population of same treatment. However, when individual characters are considered the treatment 15KR for fibre length, 20KR for ginning outturn (GOT) and 0.2%EMS for seed cotton yield were most effective.

From the above results, it may be worth to adopt 0.2%EMS or 15KR dose when breeder is aspiring for simultaneous improvement in most of the characters coupled with creating ample variability with additive nature.

Promising lines were evaluated in M3 M4 and M5 generations. The frequency of the genotypes of each group is depicted in Table-9. Amongst these genotypes mutant Number 2, 5, 6, 10 (15KR) 20, 35, (20KR), 39, 52, 54 (30KR) and strain no-89 (0.2%EMS recorded consistent performance over years over generations for most of the characters. It indicates that these lines are stable in their performance under vageries of environments and chances of inbreeding depression will be relatively less. Testing of these cultures on large scale under various agroclimatic zones may help breeder to identify a high yielding longer staple strain with wider adaptibility which has a great practical significance.

Amongst 87 lines, strain No. 85 for seed cotton yield, strain No. 30 for GOT and strain No. 10 for mean fibre length (MFL) ranked first in order of merit for
respective characters. Crossing amongst these lines and application of selection pressure in subsequent segregating generations may lead to evolve as genotype with all desired characters.

The present investigation revealed that between physical and chemical mutagens, chemical mutagen has an edge over physical mutagen. In physical mutagens, relatively higher efficacy was observed with 15KR dose.

In all, eight fibre properties were studied to understand the effect and effectiveness of mutagens. However, more weightage were given on fibre length, fibre strength, maturity & fineness as they are directly related with the yarn count. The present investigation showed that these characters can be improved to a great extent and level of diploid species can at par or superior with tetraploid cotton. Amongst the four mutagene, 15kr dose showed remarkable improvement for individual character as well as for combination of characters.

The second best from efficacy point of view, treatment 0.2% EMS which generated a wider range of variability and substantial population mean for fineness and strength. Negative correlation existing between these two characters can be reduced to a great extent with the adoption of 15KR gamma-ray treatment.