CHAPTER - 2
REVIEW OF LITERATURE

The problem of improving cotton crop has received continuous attention. Scientific effort in improving the crop has started only at the turn of the century with the invention of new technologies in industries and the need to keep the pace with the textile requirements in 21st century. It is imperative to study the fibre properties and to provide information on fibre structure to the breeder, so as to meet the requirement of textile industries. Review of the work done in improving fibre properties and fibre structure with reference to mutation breeding is reviewed.

The discovery that mutations could be artificially induced opened-up a new field in making new variations for selection. The existing genetic variability in crop plants is largely conditioned by the nature and intensity of selection. With the advancement in technology and change in human needs information regarding variability in the existing germ plasm for any new selection parameters like productivity per day, performance stability for mechanical harvesting, processing characteristics, amino acid balance, freedom from toxins etc. is not readily available as well as materials with those barometers are rarely present. They can now be artificially created by using the newer tool, mutation breeding. However artificial induction of variability revealed new prospects, mutation breeding is an
alternative method for plant improvement over the conventional methods, it is only an additional tool. As this tool becomes more perfectly and properly understood, the breeders will increasingly use it for crop improvement.

Mutation breeding is nothing but controlled and directed evolution. The importance in evolution of mutations for quantitative characters was stressed by Baur (1924) and subsequently Stubbe and Wettstein (1941). However, the convincing evidence given by Buzzati Travarso (1955) and Scossiroli (1954) on the possibility of evolving artificially suitable genotype to suit to special environments and by Gregory (1955) on the possibility of improving the response in pea-nuts (Arachis hypogaea) to artificial selection for quantitative traits, opened up a new field for use of induced mutations in plant breeding.

The efficiency of any plant breeding programme is determined by the amount of genetic variability available in the breeding population and the efficiency of selection techniques. With self-fertilizing species, on the other hand, the amount of variability in the breeding population assumes much greater importance and hence more importance of induced variability in these species. However, less efforts have been devoted to study quantitatively inherited characters despite the fact that most economic traits in agricultural species are under polygenic control.

Plant breeding, essentially involves improvement of crop to suit the needs of mankind. The extent of improvement
depends upon the variability available/generated and efficiency of selection and mutagens. Induction of mutations has come in as a very effective method of generating variability mutagenic treatments resulting in genetic change.

Induction of mutation is an unique approach in breeding for crop improvement as it creates a large amount of variability. In the recent past, lot of work has been done on the induction of mutation in different crops and its utility in the crop prospects. Though it has been now acclaimed as an excellent tool in the hands of the breeder, it took nearly three decades to realise it's importance. The mutations could be induced artificially and the spontaneous mutation frequency could be enhanced by using mutagens which forms the basis for the creation of genetic variability that could be utilized in plant and animal breeding.

The experiments of Muler (1954) on Drosophila followed by Stadler (1928) on maize and barley established beyond doubt that irradiation could greatly increase the frequency of mutations.

Attempts have been made to put into practice the theoretical basis of mutation breeding by Gustafsson (1942) in sweden. Their pioneering work provided necessary catalysis for intensive experimentation which in turn led to many spectacular achievements.
Induced mutation through irradiation is most effective. Ionizing radiations like X-rays, gamma rays, B-particles, protons and neutrons etc. with specific characteristics for each is studied. They also differ in their effectiveness and efficiency. The electromagnetic radiation like X-rays and gamma rays were the earliest to be tried in rice.

There are various chemicals that show mutagenic effect such as basic analogues, some basic dyes, alkylating agents, nitrous acid etc. Raport et al were the first to demonstrate the effectiveness of the chemical mutagens. The effect of chemicals is so similar to that they have been called "radio mimetic substances". They reported the mutagenic effect of mustard gas, an alkylnating agent. Since then, a large number of chemical mutagens are in use. Oka et al (1953) were the first to study the variability due to induced mutation of polygenes for quantitative characters in rice. They found that the mean differences did not differ significantly but the range of variability increased both in negative and positive direction symmetrically. On further scrutiny, Bateman (1959) observed no such symmetrical induction but the variability for plant height did increase after irradiation.

Studies on induced mutation with fractionation doses of irradiation have in recent years assumed importance and
significance. Sparing effect of dose fractionation (SDF) or split dose recovery is the difference between the response to single dose irradiation and a split dose irradiation and measure the extent of recovery from irradiation damage.

Effectiveness has been defined as the ratio of "factor mutation/dose" (Ehrenberg). He found higher frequency of mutations with EMS than with X-rays in rice. Apparently, DMS has relatively low toxic effects when compared with X-rays.

Swaminathan et al (1962) reported that among the various radiomimetic chemicals known, alkylating agents were found to be the most potent in evolving a wide array of organisms. It was noted by them that high frequency of particular type of chlorophyll mutants is to preferential action of EMS on chlorophyll development genes located around centromere.

Induced mutations have been extensively used to create genetic variability for various characteristics in several crop species. Such a variability has further been used to develop new mutant cultivars directly or through cross breeding. Mutations can be used as an additional source for creation of variability or to rectify one or a few undesirable traits exhibited in commercial varieties (Swaminathan et al 1968; Yadav and Kar, 1983).

Through mutations are rare in nature, their frequency can be enhanced through the use of certain mutagens. Both
ionizing radiations and chemical mutagens, particularly alkylnating agents can be utilized to induce mutations for crop improvement. Quite a few successful induced mutations have been synthesized in various crops like groundnut, NC. 4-x (Gregory, 1960); wheat, Sharbati Sonara (Swaminathan, 1969); barley, Pallas and Mari (Gustafsson et al).

The available literature on mutagens is with reference to macro and micro-mutation shows that spirituals much work has been done on this aspect in cotton crop. The available literature is reviewed as below.

2.1 MACRO MUTATIONS:

The earliest report on induced mutations in cotton is from Mckay and Goodspeed (1930) who irradiated the pollen of the variety Half and Half (G-hirustum) with X-rays. Induced mutations in G-hirustum by X-ray treatment to seeds. Mutations showed changes in leaf shape from forked to normal and leaf colour from virescent yellow to normal green.

Ayyar and Ayyar (1938) after X-ray irradiation of dry seeds of G.herberceum and G.arboreum obtained three mutants of which two were chlorophyll deficient clarbino xanthal and one of merisitic variant.

In the first generation of seedlings from X-radiation and thermal neutron treatment of seeds, the rate of growth was reduced in all treatments, very few plants from thermal neutron treatment reached maturity. Although, the X-ray
irradiated plants reached maturity but their fertility was much reduced. Abnormal plants, many of which were sterile, were found after treatment with 20 KR and 30 KR.

Brown (1948) analysed cotton plants grown from seeds of Acala 911 (G. hirsutum), exposed to radiation from the atomic bomb at Bikini in 1946, and found that chromosome structural changes were induced as in the case of those exposed to X-rays and other ionizing radiations in the laboratory. All types of quadrivalent associations were found, the zigzag N, the closed rectangle (or ring), the angular U, the angular B and the closed bivalent with attached chain of two chromosomes. The chiasma frequency was reduced. The loss of whole chromosomes, occurrence of univalents, and inversions were also noticed. The data also revealed that gamma radiation can be highly effective in producing hereditary changes in chromosome structure. Jagathesan (1960) showed that diploids are more sensitive to X-rays. Jagathesan and Sastry (1963) treated fifteen varieties of cotton, representing G. herbaceum, G. arboreum, G. hirsutum and G. barbadense, with thermal neutrons and X-rays and found that the effects of treatments were greater in the diploids than in the tetraploids, as measured by germination, survival, meiotic irregularity and pollen fertility. Ibragimov et al. (1962) reported in G. hirsutum that the rate of mutation in F1 depends on individual radiosensitivity of the seeds and increases with dosage.
Jagathesan *et al.* (1963) isolated a jassid (*Empoasca devastans*) resistant mutant in the M2 progeny of *Masoilla Acala* raised from X-ray irradiation. The mutant had 40 percent greater hair density as compared to the parent strain which they resembled in all other characters.

2.2 **MICROMUTATIONS**:

Systematic efforts for improving cotton for polygenic characters by mutation breeding are available from the Institute of Plant Industry, Indore. The germinating seeds of variety MU-4 *G. hirsutum* were irradiated with X-rays for 20 minutes. From the irradiated populations, a mutant named as Indore-2, which was superior in ginning percentage, staple length, giving 30s and also higher yielder as compared to the parent strain was isolated. Perhaps it is the first induced mutant in cotton released for cultivation in 1950.

The differences for lint percentage, seed index, lint index, fibre length, strength and fineness were significantly different from the controls in the short internode mutants reported by Pate and Duncan (1963). The mutants would be useful in mechanized farming.

Atazanov (1965) found that low doses of gamma irradiation had stimulating effect on growth, development and yield. Doses over 5 KR, had a negative influence on earliness and yield. With doses of 20KR to 30 KR, early, high yielding, large boll produced which had an altered
habit. The mutation effect of gamma rays was maintained in the M2 progeny of 108 F, S 3381 and 153 F.

Al Didi (1965) irradiated pre-soaked seeds of Ashmouni cotton variety (G. *barbadense* L.) by gamma rays from a cesium-137 source with 555, 907, 2220, 3990 r. The plant progenies of the mutants were tested by pedigree methods, from M3 to M7 generation. By the M7 generations. The promising lines were selected. The first line 19/62 was higher in GGT than Ashmouni and significantly different in quality, being longer in staple length, finer in hair weight and higher in Lea product and with bigger bolls; the second line 24/62 and its sister lines 31/62 gave yield significantly higher than Ashmouni by 32% and 19%, respectively. Besides having better ginning outturn and bigger boll than Ashmouni, the lines were higher in Lea product by 105 to 185 units, slightly longer in staple and finer in hair weight. Bhute (1966) irradiated seeds of AK 235 variety of *G.hirsutum* with gamma-rays and isolated plants maturing earlier and with larger bolls than in the parental strain. In a similar type of study, Yadao (1966) created variability for node number, boll shedding, ginning percentage and yield of progenies of *G.arboreum* and *G.hirsutum*.

Ibragimev et al. (1962) treated growing plants of 108 F with gamma rays doses from 500 to 3000 r and isolated number of mutants in M2 and M3.

Mutants with compact habit, large bolls, earliness and
higher lint quality were isolated. Mutant 1 exceeded 108 F in number of branches, boll size and number, seed weight and lint percentage, strength, yield and length. Mutant 2 exceeded 108 F in boll weight, lint percentage staple length and seed size and number. Both these mutants were induced by treatment with 2000 r during bud development. The other two arose from treatment of flowers, both were earlier than 108 F and had higher quality.

The dawn of the 'Atomic age' following World War-II saw a boom of interest in utilizing ionizing radiations for peaceful purposes. By 1950, mutation induction research began to flourish using 60 Co gamma rays. Studies on radiation treatment to alter the 'random' mutation induction in to more targeted, specifically desirable and economically useful. The basic tools of plant breeding are selection, recombination and mutation. Seed radiation is a classical method of mutation induction because of easy handing and better reproducibility. Mutation breeding with better resistance to stress, pathogens and pests with improved quality characters. Mutations are said to occur more or less random. Hence there is no clue as to the kind or magnitude of genetic change. There is no doubt that the proper use of induced mutation breeding requires screening of large plant population to obtain desired mutations.

Certain chemical mutagens proved more desirable for plant improvement than radiation. Now the crucial bottleneck is being mutant selection. It is observed that of radiation
or chemical mutagens are preferred and desirable as compared to high frequency mutations given by certain supermutagens. Induced mutations in future will play an even greater role for the success of plant improvement.

The so called 'Green Revolution' had made it very clear that genetic improvement of crops has the capacity to dramatically increase the plant products.

The concentration of chemical mutagens and duration of treatment to obtain large mutation spectrum. Chemical mutagens have much greater advantages over ionizing radiation due to milder effect on the genetic material of a cell causing less chromosomal damage than radiation which break the covalent bonds without directly reacting with the nucleotides. Secondly, the chemicals induce more mutations than physical mutagens. The proportion of economically valuable mutations and their diversity is also greater.

Chemical mutagens has created new trait of breeding value, carrying new genes, controlling resistance to diseases and other stress factors of environment and determining high yields of superior quality. An extremely important advantage of chemical mutagen over radiation is their ability to induce dominant inductions with high frequency. The dominant mutations will be larger if one treats dry seeds with chemical mutagens as dry seeds contain fewer initial cells at the time of treatment.

The presence of dominant genes determines high viability of plant organism and ensures fuller use of
nutrients sphere of plants activity and biochemical process more frequently, which could increase yield, quality, deseasees and pest resistance. Advantage of chemical mutagens is the specificity of their action which can be detected by comparing the aberrational effects and spectra of induced variability.

2.3 CORRELATION STUDIES IN COTTON :

Ginning out turn, lint index, seed index, staple length, strength, maturity coefficient and fineness are some of the important characters associated with the economic attributes and quality of the cotton fibre knowledge of the correlations that exist between these characters would be important from the breeding point of view.

Swami Ana (1986) in G. arboreum studied the effect of X-rays and MMS from M2 to M6 generation and related suitable lines for increased number of fruiting branches per plant; increased number of bolls/fruiting branch and increased percentage of fruiting branches.

Seeds of G.barbdance were exposed to 5, 10, 20, 25 and 35 KR dose, and reported higher boll weight in M2 than M1 while marginal differences amongst various doses. They observed less marked effect of X-rays in M2 as compared to M1.

The possibility of improving cotton yield through radiation mutagens and reported 15 KR dose as a most effective in producing high yielding mutants. The contradictory results and noted reduced boll size and fibre
yields. Significantly reduced mean for seed cotton yield and other characters except lint percentage. Shroff and Srinivasachar (1977) studied the effect of various physical and chemical mutagens on phenotypic and genotypic correlations in M2 generation. They reported positive association between halo-length and ginning outturn (GOT), Seed Index (SI) and Lint Index. They concluded that the effects depends on the mutagens and doses used.

Nazirov et al. (1986) after a detailed study concluded that the susceptibility to radiation was not related to chromosome number.

Kurepin (1985) expressed seeds of G. hirsutum variety Tashkent and found that the mean value of quantitative traits decreased as the radiation dose increased. There was increase in variation but in most of the cases, variance were undesirable. They further reported that variety selected in M1 expresses usually a progeny with poor survivability compared with untreated control. Phenotypically normal plants of M3 showed a 3-5 fold increase in variation in quantitative traits. They concluded that better effects can be obtained by providing separate treatments rather than using a combination of physical and chemical mutagens.

Mukha and Sarov (1983) observed no association between sensitivity to mutagens and mutability.

Observations recorded by Kuliev and Asker Beli (1970)
indicated contradictory results about the effect of combinations of physical and chemical mutagens. They observed higher sensitivity and desirable effects from combined rather than individual treatments.

Azizov (1968) in *G. hirsutum* found that viability and variability in M1 were related to the dose and rate of seed irradiation. Higher the dose rate, the lower viability and greater variability.

In a study of effect of chemical and physical mutagens on variability of characters conducted by Egamberdiev and Mustanev (1971) it was observed negative and undesirable types of changes after the treatments with X-rays and combined treatments.

It is observed decrease in seed viability with increase in irradiation dose. The mutations obtained by them were different from the initial varieties in growth period, branching type, leaf & boll size and shape.

Shyam (1970) reported superiority in fibre quality of lines evolved by mutations. Similar results were also reported by Gulamer and Narinev (1973).

Furgo and Knoplyc (1973) Nazirov (1968) reported that fibre fineness and elongation were significantly increased, while significant reduction in 2.5% span length was observed in *G. hirsutum*. Egamberdiev (1971) observed negative correlation of fibre length with fibre-yield and maturity period. However, they further observed a positive relationship when seeds were exposed with combination of
physical and chemical mutagenes.

Kannian et al (1971) isolated mutants with 16% higher ginning outturn (GOT) over control and significantly higher fibre length and lint index.

Leak (1914) determined the factors controlling ginning percentage and come to the conclusion that it is a complex character determined by the number of fibres per seed, weight of individual fibres and volume of the seed of which had a marked effect.

Patel and Patel (1927) reported a weak negative correlation between ginning percentage and staple length in G. herbaceum. Patel (1922) found a high positive correlation between seed index and lint index in this species. Patel and Mankad (1925) found no correlation between seed index and staple length in the Wagad variety of G. herbaceum. Low but significant correlations between upper half mean length of fibre and fibre strength in 50 varieties imported from U.S.A. was observed.

Gulati and Ahmad (1935) reported non-significant correlation coefficient between fibre maturity and mean fibre length. However, detailed analysis of the data showed that majority of the short staple cottons possessed a high percentage of mature fibres while long staple cottons were characterised by a low percentage of mature fibres. High fibre maturity was significantly positively correlated with high fibre weight per inch (r=0.60) and fibre strength (r=0.72).
Sikka and Afzel (1947) in a study on the effect of crosses found the tendency of the cotton fibres to become coarser as the ginning percentage increased. However, since the positive correlation between fibre weight per unit length and ginning percentage failed to reach the level of significance, there could be still chances for the breeder to select finer types with high ginning percentage.

Breeding for larger seeds improved fibre characters but reduced ginning percentage. But when ginning percentage was improved, all fibre characters were adversely affected. Fibre density decidedly improved the ginning percentage but adversely affected fibre strength and maturity. In one of the three crosses made by Thurman and Henderson (1956) between high and low density, there was a relatively high negative association between strength and lint density. Lint density index (weight of lint in gms per 100 square centimeters of seed surface area) was highly associated with fibre number. Mason (1951) made actual counts of fibre number per unit area of seed surface on 12 F2 plants and found an essentially perfect correlation between fibre number per unit area of seed surface and lint density index.

Yousuf and Abdul Hafez (1962) showed that in spite of their coarseness Egyptian cotton had a higher fibre strength, the correlation coefficients between the fibre weight and yarn strength being + 0.93. A positive correlation between seed weight and fibre weight showed that fibre density could be improved by selection for high seed
weight. Finley et al. (1964) reported a positive correlation between seed weight and fibre weight and showed that fibre density could be improved by selection for high seed weight. Finley et al. (1964). It is observed that fibre strength and fibre length were positively correlated.

It was observed that maturity coefficient was significantly positively correlated with fineness and fibre bundle strength but there was no significant partial correlation between fineness and fibre bundle strength. Thus, it was not possible to select very high strength accompanied by higher fineness.

Miller reported that as lint yield was increased, lint percentage, earliness, fibre elasticity and micronaire values also increased while boll size, seed index, fibre length and strength decreased with the increase of lint yield. Kamel and Ismail (1966) reported a low but positive correlation between fibre length and fineness. The genetic linkages in MGI Mocotype cotton for the following characteristics was observed.

Yield and ginning out turn (GOT) with fineness (micronaire value); single boll weight and ginning out turn with fineness and fibre maturity with seed weights staple length with pressley index and yarn count. Yield was not found to be genetically linked to staple length and pressley index. Due to strong selection pressure within the genotype, staple length, tensile strength and yarn count can be regarded as stable characteristics.
Variation between lines was larger for yield, single boll weight, ginning out turn and seed weight but less for pressley index, fibre maturity and fineness.

Patil (1966) studied 30 varieties of G.arboreum and found that highest variability was obtained for halo-length, number of locules per boll, ginning percentage, leaf index, and boll weight. Number of bolls per plant and plant height were closely associated with yield. Butany et al (1966) found that boll number was positively correlated with seed index and negatively with boll weight and ginning percentage. Boll weight had high positive correlation with lint index. Halo-length had a high positive correlation with lint index and seed index while negative correlation with ginning percentage and lint index. Ginning percentage and seed index were negatively correlated.

Al-Jibouri et al. (1958) in the F3 generation of G.arboreum X G.herbecium found positive correlation between lint yield and ginning outturn (GOT), negative correlation between fibre strength and lint yield and no correlation between fibre strength and lint yield and lint yield with fibre fineness.

Chandramath (1973) indicated that seed weight and lint index had the biggest influence on ginning percentage. The seed weight influence was negative, indicating an association between small seeds and high ginning percentage.

Deshpande et al (1978) found that seed cotton yield per plant was positively correlated with number of bolls per
plant, both genotypically and phenotypically. Ginning outturn showed a highly negative genotypic association with mean halo length.

Dhanda et al (1984) in their studies found that genotypic correlation were higher than phenotypic correlations. Seed cotton yield was highly and positively correlated with bolls per plant, plant height and seeds per boll.

Faqir et al (1984) reported that boll number per plant, boll weight, seed index, lint index and ginning percentage were positively and significantly correlated with seed cotton yield. Staple length showed a significant negative correlation with yield.

According to Cheng and Zhao (1991), fibre strength was negatively correlated, while lint percentage was positively correlated to lint yield per plant. Seed cotton yield was significantly correlated with seed yield per plant. lint yield per plant, number of bolls per plant, ginning percentage and seed and lint indicates, with seed yield per plant having the greatest direct effects.

Tyagi (1987) reported that seed cotton yield showed significant positive association with number of bolls per plant, boll weight, seeds per locule, ginning out turn, fibre fineness, lint index and fibre maturity coefficient. Fibre length and number of loculi per bolls were significantly and negatively associated with seed cotton yield. Selection indicates showed that bolls per plant and
boll weight together with other characters contributed 70 per cent of the total variability for seed cotton yield.

It is observed that the yield components were positively correlated with lint yield, while the main fibre quality traits including fibre length, fibre strength and micronaire value were negatively correlated with lint yield. Increasing the lint index and decreasing seed index were advantageous for increasing lint percentage and boll numbers per plant but detrimental to boll weight.

Lu et al (1994) confirmed that rate of boll opening was stable trait. Rate of boll opening correlated with yield components as well as fibre length and uniformity but had a significant or highly significant negative correlation with fibre strength, length and micronaire value. Number of bolls per plant had the most important effect on lint yield.

2.4 STABILITY PARAMETERS:

In the past, crop improvement programme was mainly based on selection in the locally adopted varieties and hybrid population. Plant breeding programme have mostly been based on knowledge of genetic architecture of economic traits along with the stability in the performance of the genotypes over environments.

Enough literatures in cotton are available on the aspects such as origin, floral biology, breeding systems. Number of reports are also available on the inheritance of quantitative and qualitative characters, heterosis and combining ability analysis, inter and intra specific
hybridization, mutation breeding and breeding for pest and disease resistance. The results of different investigators are often inconsistent because of differences in genetic make up of the material used for study, use of different mating designs (methods) and the presence of high genotype x environment interaction in cotton.

2.4.1 Adaptibility (stability) and G X E Interactions

2.4.1.1 Concept of Stability:

To maximise the available variability in crop plants and attempt to select the best adapted types, success of which depends upon the recombinational variability. This variability deviates from crop to crop depending upon the mating system. Variability which is of prime importance to the plant breeder depends upon the mating system and evolutionary history of crop species. The regression analysis of yield of environmental index as measured by the mean yield of all the varieties in a particular environment.

Eberhart and Russell (1966) observed that corn hybrids with a regression coefficient less than 1.0 usually had mean yield that were below average. Accordingly, they suggested that a desired variety has high mean, regression coefficient equal to 1.0 and variance due to regression as small as possible. Thus, they modified the regression technique which enables partitioning of the genotype x environment interaction of each variety into two parts; b, the variation due to response of the variety to varying environmental
indices (sum of squares due to regression) and the unexplainable deviation from the regression on the environmental index. They defined both the linear (bi) and non-linear (S^2 di) components as a stability parameters. Both the components, bi and S^2 di suggested by Eberhart and Russel (1966) are subject to genetic control and are at least in part subjected to different genetic systems.

2.4.1.2 Stability in cotton:

Miller et al. (1958) studied and proved the important of genotype X environment interaction for lint yield in cotton, where as yield components and fibre properties did not prove to be important in this respect.

Bhatade and Bhale (1983 b) studied eight yield related characters in seven parents diallel set grown at three locations and observed significant G X E (linear) effects for seed cotton yield, bolls per plant and sympodia per plant where as, pooled deviations (non-linear) were important for boll weight, halo length, ginning outturn, seed index and lint index.

Bhatade et al (1994) studied stability analysis of seed cotton yield in upland cotton. The 9 genotypes were tested at 4 locations in Maharashtra. NHH-44 gave highest overall mean yield of 1541 kg/ha while NG-452 and NH-450 were rated as most stable.

Phenotypic stability in upland cotton (Gossypium hirsutum L.) for bolls per plant, ginning outturn and seed cotton yield
in 10 genotypes. Linear component was important for seed cotton yield, whereas, no-linear component for bolls per plant and ginning outturn was observed.

The literature reviewed, thus, shows general agreement that G X E interaction is of considerable importance in cotton and thereby may be a bias if the genetic estimates not made on the basis of observation of single environment.