Chapter-2

Review of Literature
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Blixt et. al. 1966 indicated that the EMS treatment affect the germination, growth, leaf spotting and mutation rate in *Pisum sativum* L. They further reported, that the growing conditions of the next generation also affected germination, seed yield and mutation rate.

Chen and Gottschalk 1970 indicated that the seed on plants treatment with gamma rays and EMS of *Pisum sativum* earliness is due to forming the first flowers at very low nodes of stem. The diversity in terms of genetic and physiologic properties of early maturing mutants arising from a common ancestry emphasizes the importance of induced mutation in breeding germplasm bore.

Moh 1971 treated the seed of three black varieties of *Phasieolus vulgaris* L. with EMS and gamma rays. From M₁ generation mutant plants were isolated with seed coats of white, yellow and various shades of brown. He noted that the mutants were similar to the parent in morphology and growth habit, but had white flowers instead of red.

Ilieva - staneva 1973 reported that in french bean the higher concentration of EMS had greater depressing effect in the M₁ with higher mutational frequency in the M₂ generation than fast neutrons. Valuable mutants with 13 to 18 % higher seed yield than control were also obtained following EMS treatments.

Appa Rao and Jana 1976 treated the seeds of black gram with EMS and gamma rays. From M₁ generation mutant plants were isolated with seed coats of white, yellow and various shades of brown. The production of crop highest average yield.
Hussain and Salim 1974 reported that the EMS was much superior to gamma rays for inducing high frequency and wider spectrum of mutation in *Pisum sativum*. Higher mutagen does lead to decline in mutation rate and on changes in the mutagen dosages. Salim et. al. 1974 also observed a negative correlation between EMS dosage and germination percentage in peas.

Sano 1976 reported that in *oryza glaberrima* the EMS led to the discovery of waxy mutants. The existence of such waxy globerrima rice could be predicted because of the general occurrence of this variation in many species of grain crops. Because induced mutations may appear in every direction. It will make possible to produce any types that by other.

Igizarian 1981 reported that the doses of 8 and 10 kr. were the best for inducing mutations in four varieties of French bean studied. The mutations induced those of chlorophyll and those affecting the test colour, Leaf blade shape, and plant height and maturity period.

Buss 1983 In *Cicer arietinum*, natural variation if simply the product of spontaneous mutation, moulded by recombination and natural selection. Any mutation that has occurred naturally can be induced and probably many which has either never occurred spontaneously, or have been lost from the natural populations. It is the many geneticists that spontaneous and induced mutations do not differ qualitatively from each other.

Haq et.al. 1984 reported that the gamma rays Pods resistant of *Ascochyta* blight disease of chickpea, namely CM – 72. This mutant cultivar covered in 1987 more than 40 % chickpea growing area in to country and has helped greatly to stabilize chickpea production.
Rao (Subba-Rao-V) et. al. 1986 heritability studies on EMS treated green gram (Vigna radiata L. Wilczed). Seeds of 3 cultivars were treated with ethyl methane sulphonate (0.05 or 0.1 %). Seeds from M2 plant were similarly treated and space planted. Heritability estimates for seed yield were lower in most treated populations than in controls. Heritability increased with dose in population treated with EMS but decreased with dose heritability increased with dose in population treated once with EMS, but decreased with dose in populations treated twice, this being attributed to damage caused by high EMS dose. Khan, I.A. 1989 studies on pattern of induced mutability in mung bean. The frequency and range of viable mutation induced by gamma rays, ethyl methane sulphonate (EMS) and hydrazine hydrate (HZ) in the M2 were determined after treating dry seeds of the Vigna radiata varieties G65 and PS-16. Mutation frequency was in linear relation to mutagen dose. The frequency and range of mutation were lowest with HZ and highest with EMS. The mutagen-resistant variety G65 gave a lower frequency than the sensitive PS-16. There was a wide range of mutation types. The most frequent were those affecting leaf morphology, plant habit, maturity data and fertility. Some leaf mutants appeared useful for breeding.

Fadl 1987 subjected two varieties each of French bean and peas to gamma radiation at 8 and 10 kr. dose. Further the samples were treated with 0.5% and 1.5 % per cent EMS. He observed some M2 mutant lines which gave high yield and mutant characters affecting high, earliness, pod shape and flower color in M3.

Rao et. al. 1987 treated the seeds of 3 cultivars were treated with 0.5 or 0.1 % EMS. Seeds from the resulting M2 were similarly treated and space planted. All treated populations out yielded the control un ML33, most in K851 and only one in PIMS2. Selection response for seed yield was greater
in populations derived from treated than from untreated seeds in ML 33 and 
K 851. Changes in seed yield compared to control were not linear in the 
different recurrent treatments.

Seeds of wild *Vigna sublobata* (resistant to *Callosobruchus maculatus*) 
and the susceptible cultivars PS 16 (*V. Radiatus*) and T9 (*V. Mungo*) were 
exposed to gamma rays (10-40 Krad), ethyl methane sulphonate (0.1-0.4%) 
or both control, M1 and M2 plants were exposed to the pest on the 
laboratory. Mutation from susceptibility to resistance or vice versa was not 
observed, but some high yielding visible mutants obtained in *V. radiata* and 
*V. mungo* were less preferred for ovipositor than their source cultivars( 
Ignacimuthu et. al. 1987).

Singh et. al. 1987 induced vine mutant in *Vigna mungo*, dry seeds of 
the variety T9 were gamma irradiated with 10, 20 or 30 Kr, and then treated 
with 0.25 % EMS. Vine mutants were characterized by long internodes; 
pollen fertility and maturity period were unchanged. F2 segregation ratios 
showed that the mutation was controlled by the single recessive gene. 
Mutants had more pods, branches, leaves and nodes per plant than the 
control, more seeds /plant. Protein content was higher in the mutant and the 
contents of 17 amino acids are tabulated.

Khan and Ali 1987 reported the mutagenic effects of gamma rays (10, 
20 or 30 Kr) and Sodium azide at 0.01, 0.02 or 0.03 % on *V. radiata* 
germination and seedlings growth were studied in CV. PS - 16 and ML - 131. 
Increasing irradiation and Sodium azide concentration decreases seed 
germination and survival. Both parameters were consistently higher in CV. 
ML- 131 than PS-16, and the latter CV was more susceptible to the 
treatments as measured in terms of seedling height and percentage inquiry.
Treatment with 0.01 % Sodium azide had a similar effect on the recovery index as 10 Kr in PS- 16 and as 20 Kr in ML-131. Sodium azide was considered an effective mutagen for *V. radiata*.

Lamsejaan et. al. 1987 indicated that the use of radiation in mung bean breeding. Seeds of *Vigna radiata* CV Uthong-1 were treated with either EMS or gamma radiation. Ten of the resulting plants (9 from gamma radiation treatment and 1 from EMS treatment) selected for resistance to leaf spot caused by Cercospora (*C. canescens* and *Mycosphaerella cruenta*) were assessed in yield traits during 1985-86. Six of the mutant lines performed well, especially 50k (25) and 50k (26.1) which gave higher yields than those of control (Uthong-1,kamphaeng saaen-1, kamphaeng saeen-2 and CEs1021). Another promising line, 50k (69) had a high yield and the highest seed weight.

Hung 1988 studied the effect of EMS and gamma rays on pollen fertility in two varieties of pea's viz. Gloria and Erica. The percentage pollen fertility in both the cultivars was closely correlated (0.9) with gamma radiation does. The pollen sterility was higher with gamma rays compared to EMS at the highest concentration.

Seeds of variety K-851 were exposed to 3 doses of gamma rays, and a batch of seeds from each dose was also treated with ethyl methane sulphonate. A dwarf mutant noticed in the M2 and true breeding in the M3, had increased number of pods / plant and seeds /pod, which led to higher seed yield. The mutants matured in 54 days compared with 60 in K851 were exposed to 3 doses of gamma rays, and a batch of seeds from each dose was also treated with EMS. A dwarf mutant noticed in the M2 and true breeding in the M3, had increased number of pods/ plant and seed/ pod,
which led to higher seed yield. The mutant matured in 54 days compared with 60 in K 851 (Pandey et. al. 1988).

Khan 1988 (a) screened eight M4 lines of CV. G 65 for salinity tolerance at 0.02 % and 0.04 % Mace. Seedling, root and shoot lengths were significantly affected by salinity. Variability for salt tolerance was greater in the mutants than in controls, but only G- Th 121 (obtained by treatment with 13 Kr gamma rays) showed increased tolerance. Mutants isolated after treatments with ethyl methane sulphonate and gamma fays showed dose dependent increase in variability for these traits while mutants obtained by Hz (Hydrazine) treatment showed on such relationship.

Kohli and vashishat 1988 isolated Srain SMRB from Vigna radiata plants was found to be sensitive to Ampicillin and resistant to chloromphenicol and Teramycin. Cell suspensions of SMRB were treated with UV light; EMS and epichlorhydrine. Colonies of exotrophs were obtained only following the EMS treatment. Om media supplemented with individual's amino acids, mutants auxotrophic for arginine, vline, adenine, histidine and lysine were isolated. When used to inoculate seedlings of V. Radiata CV. K 851. Only the lysine and valine requiring mutants were ineffective.

Khan1988 (b) evaluated three quantitative characters in CVG 65 after treatment of seeds with gamma rays and EMS used either singly or in combination. Mean values for all three characters (number of pods, 100 seed weight and seed yield) increased in theM$_2$ as compared to the control. Total phenotypic variability increased, as did the values of the phenotypic and genotypic coefficients of variation.

The 2C nuclear DNA content per cell in the M$_1$ following mutagen
treatment (ethyl methane sulphonate) EMS, gamma rays or EMS+ gamma rays of seeds was determined by cytophotometry in wild *Vigna sublobata* and cultivated *V. mungo* and *V. radiata*. In all 3 species the 2C amount decreased with increase in mutagen dose, except for some treatments where there were increase. The EMS + gamma rays treatments showed the most marked reductions. It was thought that the reductions were due to induced deletions, while the increase were due to translocations. Nuclear volume was generally unaffected by the treatments. RNA contents per cell decreased with increased mutagen dose. *V. sublobata* had lower DNA and RNA contents and nuclear volume than the cultigens (Ignacimuthu and Babu 1988).

Ignacimuthu et. al. 1988 indicated radio sensitivity of the wild and cultivated Urd and Mung bean. Seeds of *Vigna radiata* (PS-16), *V. mungo* (T9) and *V sublobata* (a wild relative) were treated with EMS and gamma rays. Doses of 0.1, 0.2, 0.3, ans 0.4 % EMS 10, 20, 30 and 40 Kr gamma radiation and combined treatment (0.1 +10 Kr, 0.2 + 20 Kr, 0.3 + 30 Kr and 0.4 +40 Kr) were employed. Mutagenesis lowered dehydrogenase activity in the M1 and M2 of all 3 species. Dose dependent decreases were noted in seedling emergence and height, survival and pollen sterility. The spectrum and frequency of chlorophyll mutations increased with dosage. *V. sublobata* was more resistant that the 2 species while *V. radiata* was the most sensitive. *V. sublobata* is thought to be more closely related to *V. mungo* than to *V. radiata*.

Ignacimuthu and Babu 1989 seeds of *Vigna sublobata*, *V.radiata* CV PS16 *V. mungo* CV T9 were subjected to 0.1-0.4 % ethyl methane sulphonate , 10-40 kr gamma rays and combinations of both mutagens. There was a dose dependent increase in the frequency of different meiotic
abnormalities in the $M_1$ and $M_2$ of all three species. The presence of univalent, trivalent and multivalent suggested that point mutations or desertions, inversions and translocations had occurred. There was a positive and highly significant correlation between chromosomal abnormality and pollen sterility ($R=0.82-0.98$). Pollen sterility in the $M_1$ and $M_2$ was highest in $V. radiata$ and lowest in $V. sublobata$.

Seeds of CV Ps 16 were treated with 0.05-0.2 % ethyl methane sulphonate and 5-20 Kr gamma rays. Chromosomal aberrations such as univalent, trivalent, multivalent. non-orientation of chromosomes. Clumping, laggards and micronuclei were observed at various dose treatments. Pollen fertility decreased with increasing mutagen dose. There was a positive and significant correlation between chromosomal abnormality and pollen sterility (Ignacimuthu and Sakthivel 1989).

Iqbal et. al. 1989 reported that germination and growth response of black gram ($Vigna mungo$ L. Hepper) to ethyl methane sulphonate (EMS). Increasing EMS concentration (0.1, 0.2, 0.3 and 0.4 %) singly and in combination. Data on the $M_1$ and 6 yield components revealed high level of genetic variance, heritability and genetic advance in most of the traits. Marked variation between the treatments and between species was noted.

Khan et. al. 1989 reported pentafoliate leaf mutant of black gram ($Vigna mungo$ (L) Hepper). Presoaked seed of CV. T9 were treated with Sodium azide solution (0.1-0.4 %) for 6h at $27^0 C$. a mutant with pentafoliate further than normal foliate leaves was obtained in the $M_2$ from the 0.4 % treatment. The mutant breed true in the $M_3$ and $M_4$. It matured 10-15 days earlier than T9 but yielded less. It first pair of leaves petiolate rather than sessile as in the parent.
Mahna et. al. 1989 indicated the mutagenic effect of Sodium azide on black grain (Phaelous mungo L.) in the M₁ after treatment P. mungo (Vigna mungo) with NaN₃, abnormalities included opposite branching and cotyledon and compound leaf changes and adverse effects on percentage and seed germination, seedling emergence and plant height. The last three were dose related. Most aberrations are not appeared in the M₂ population. A chlorophyll mutant lethal after 20 days and a facilitated mutated in the M₂. Study of subsequent generations indicated that both mutations were monogenic and recessive.

Saini et. al. 1989 reported that the induction of mutation in mung bean. Dry seeds of Vigna radiata CV Pusa Baisakhi were treated with various ethyl methane sulphonate concentrations for 20 hrs. information is presented on 5 chlorophyll mutants (Alboviridis, Albina, virescens, albescens and macultata) and 3 morphological mutant (erectoid, unifoliata and dwarf) selected in the M₂. The inheritance of the mutations in the M₃ indicated that they were all monogenic recessive types.

Mahna et. al. 1990 indicated nodulation studies with induced mutants of black gram (Vigna mungo L.). Soaked seeds of CV T9 were treated with hydroxylamine or Sodium azide. M₃ mutants termed high modulating, excessively branched and dwarf, were analyze. Compared with the control, the dwarf mutant showed a reduction in nodule number, root and shoot length and dry weight, total N and seed protein content.

Kulkarni et. al. 1990 induced mutagenesis and selection response for yield in green gram. Seeds of Vigna radiata varieties PIMS1 and Pusa-Baisakhi were treated with gamma radiation and EMS. High yielding selection was made in the M₂, some of which produced M₃ progenies, which
Haq 1990 genetic and physiologic studies on induced mutants of three kabuli chickpea genotypes viz ILC 482, ILC 3279 and ILC 6104 were caviled out. Physical mutagen (gamma irradiation), and chemical Mutagen (ethyl methane Sulphonate) were used to create genetic variability, and subsequent selection of mutants. Prior to the mutagenic seed treatment, conducted to obtain useful inducing genetic variability, and to estimate the doses of gamma irradiation and EMS effective to reduce the growth (shoot & root). The shoot & root length decreased at higher doses of gamma irradiation and EMS. The sensitivity to gamma irradiation and EMS appeared to be related with the seed size. The large seeded genotype ILC 6104 seemed to be more sensitive than ILC 3279 & ILC 482. It appeared that shoot and root length reduction can be used with equal reliability for estimating the appropriate mutagen dose. Three gamma irradiation doses (40, 50 and 60 Kr), and two EMS doses (0.1 and 0.2 %) which caused reduction in the shoot and root length around 20-40 % were chosen for large scale mutagenic treatments. The order of radio sensitivity appeared to be ILC 6104 > ILC 3279 > ILC 482.

Singh et al. 1991 induced mutations for qualitative and quantitative traits in green gram (Vigna radiata L. Wilczek) CV T44. Dry seeds of T44 were exposed to gamma rays (5-40 Kr), ethyl methane sulphonate (EMS 0.01-0.05 M), combination treatments (5-40 Kr gamma rays doses followed by 0.02 M EMS) and recurrent dose of gamma rays (5-40 Kr with further doses in the following generation). M₂ mutations were observed for the characters plant height, plant height, branching pattern, leaf morphology, venation, pigmentation, peduncle length, pod characters, male sterility, maturity seed color and yield, distinct mutant were advanced to the M₃
generation and data for certain quantitative characters such as plant height, time of flowering, pod/plant and seed yield/plant, were recorded to assess their usefulness. The dwarf mutant VR Df-1 is a possible new source of dwarfism and the unbranched mutant VR-Urd may be useful for increasing plant population/unit area. The mutants VR Mra-19, VR Hy-30, VR Sh-16 and VR Bu-3 showed significant increase in pods and seed yield/plant.

Sarma et al. 1991 induced genetic diversity in mung bean (*Vigna radiata* L. Wilczek). Variability and genetic divergence for 8 yield components were studied in 34 micro mutants of mung bean and 2 base genotypes obtained by gamma irradiation (10, 20 and 30 Kr) and treatment with ethyl methane sulphonate (0.1, 0.2, and 0.3 per cent), singly and in combination. Primary branches, pods per cluster and clusters per plant showed high heritability with high genetic advance. On the basis of D2 values, micro mutant could be grouped onto 9 clusters, indicated that mutation are effective in creating genetic divergence. Primary branches, pods per cluster and days to maturity contributed most to the divergence of the micro mutants.

Vanniarajan et al. 1991 reported genotype sensitivity of urd bean in *M1* generation of mutagens. Seeds of *Vigna mungo* varieties ADT3 and Vamban 1 were treated with 9 and 5 doses of gamma irradiation (20-100 Kr) and ethyl methane sulphonate (20-70 ml) respectively. Based on 8 characters evaluated, genotypic differences were found in the *M1* generation in response to both the type and dose of mutagen. Reasons for the genotypic differences observed are discussed.

Singh et al. 1991 reported bold seeded mutant in black gram. Dry seeds of black gram (*Vigna Mungo*) cultivar T9 were irradiated with a gamma
ray source followed by EMS (ethyl methane sulphonate) treatment. A bold seeded mutant was selected in the M2 a subsequently evaluated in the M3. It showed more vigorous growth and produced more leaves and pod, larger seeds and almost double the yield (16.8 Vs 9.0 g) compared with the control. Further evaluation up to the M8 showed the mutants to be stable.

Tripathy 1992 reported that the effect of mutagenic treatments on micro mutations in Mung bean (Vigna radiata (L.) Wilczek) seeds of dhauli and kurda local were subjected to 0.2, 0.4 and 0.6 % ethyl methane sulphonate (EMS) in combination with gamma radiation (5, 10, 15, 20 and 30 Kr). In the M2 a total of 12 characters were recorded and it was found that 30 Kr gamma irradiation produced the highest frequency of macro mutations. This was followed by 15 Kr + 0.6 % EMS, 10 Kr +0.4 % EMS and 20 Kr gamma radiations. Combination treatments of low doses of EMS and gamma radiation are recommended for inducing mutations in yield components.

Charumathi et. al. 1992 indicated that the efficiency of early generation selection for induced micro mutations in black gram (Vigna mungo L. Hepper). Dry seeds of variety LBG- 17 (Krishnaiah) were treated with gamma rays (10, 20, 30 and 40 Krad), 0.4 % ethyl methane sulphonate and 0.015 % n-methyl-n-nitroso urea singly and in combination. For the characters days to 50 % flowering days to maturity and plant height, selection was confined mostly to the M2 generation because not much advantage was expected by advancing the mutagenized population of that M3. However in the M3 generation compared with the M2, variation was greater for number of branches and pods per plant, pod length, seeds per pod, seed yield per plant, 100 seed weight and protein percentage. Some desirable micro mutational progenies for early maturity, more branches per plant, high pod and
Ignacimuthi and Babu 1992 induced variation in pod and seed traits of wild and cultivated beans. With a view to evaluating the induced genetic variation in yield traits of wild and cultivated Urd and Mung bean, seeds of *Vigna radiata*, *V. mungo* (Cultivars) and *V. sublobata* (wild Relative) were treated with ethyl methane sulphonate and gamma rays separately and in combination. There was a broad spectrum of induced variability for most yield traits in $M_2$ plants. Genetic variance, heritability and genetic advance were high for most traits; the results demonstrated that induced mutations are random, poly directional and quantitative in nature. The wild relative was more resistant than the cultivars.

Gautam et. al. 1992 reported mutagenic effectiveness and efficiency of gamma rays, ethyl methane sulphonate and their synergistic effects in black gram (*Vigna mungo* L.). Data are tabulated on the percentage of pollen and ovule sterility after seed treatment of $T_5$ an improved variety with gamma radiation (5, 10, 20, 30 and 50 mm), both singly and in combination (20 nm EMS only). Values were calculated for mutation frequency, effectiveness and efficiency, and the synergistic effects of the combined treatment were assessed; gamma rays were more effective than EMS, whereas EMS treatment alone was 2 - 2.5 times more efficient in inducing mutation. A progressive increase in mutation frequency of chlorophyll and viable mutations was observed with increasing doses. Synergistic effects were observed for increasing mutation frequency in the $M_2$ generation.

Goswami et. al. 1993 reported phenotypic stability of yield and its components in the $M_5$ generation of green gram. Genotype X environment interaction and phenotypic stability for seed yield and other yield contributing
attributes were investigated over 6 environments in 34 micro mutants induced by treating Vigna radiata varieties AAU 34 and AAU 3.9 with gamma rays and EMS. Mutant MM4 exhibited average stability for seed yield and 100 seed weight. MM1, MM2, MM3, MM5, MM6, MM7, and MM17 might be adopted for favourable growing conditions, while MM10, MM11 and MM12 could be exploited in breeding programmes to transfer linear stability to otherwise desirable genotypes.

Singh et. al. 1993 indicated the mutagenic response of mung bean (Vigna radiata L. Wilczek). Speeds of cultivars Sona and Ps-16 were treated with three concentrations (0.20, 0.30 and 0.40 %) of ethyl methane sulphonate (EMS) and hydroxylamine (HA) separately or combined, and in combination with 2 gamma irradiances (25 and 35 Kr). Germination on the 3rd and 4th day of treatment was recorded. Both chemical mutagens at higher concentration and in combination with gamma rays were effective in modifying the seedling traits in both cultivars.

Hepriba et. al. 1993 induced variability in the M3 and M4 mutants in Urd bean. Dry seeds of Vigna mungo Vamban-1 and ADT 3 were treated with 20 - 70 mm ethyl methane sulphonate. The genotypic coefficient of variation (GCV) was high for plant height, primary branches, clusters and pods / plant showed high variability both at the phenotypic and genotypic level. GCV was, in general, higher in Vamban-1 than in ADT 3, GCV 3 for primary branches / plant, clusters / plant, clusters / plant and 100 seed weight were higher in the M3 than in the M4 in both varieties. Variability decreased from the M3 to the M4, high heritability coupled with high genetic advance was recorded for yield/ plant, cluster number and pods/ plant.

Kansagra et.al. 1993 variability studies in induced mutant in mung
bean seeds of vigna radiata c v k 851 were exposed to 15 and 20 kr dosed of x radiation and/or treated with ethyl methane sulphonate and diethyl sulphate variation for pod length seed/pod and 100 seed weight was studied in the M₁ and M₂ generations; all treatments had a deleterious effect on pod length; most also adversely affected the other 2 traits studied; in the M₂; variance within mutagenic treatments due to progenies was significant for all 3 traits in the majority of combined treatments and in some of the individual treatments.

Ignacimuthu and Babu 1993 induced quantitative eradation in wild and cultivated Urd and Mung mean. Ethyl Methane Sulphonate and gamma radiation were used to induce mutations in Vigna tadiata, V. mungo, and V. sublobata. Variation in 5 traits was noted in the M₃.

Vanniarajan et. al. 1993 induced sterility in black gram by using EMS and Gamma rays. information in tabulated on pollen sterility, seed fertility and number of sterile mutants in black gram (Vigna Mungo L.) genotype ADT3 and Vanban-1 after treatment of seeds with gamma rays (20-100 Kr) or ethyl methane sulphonate (10-70 mm).

Khanand and Siddiqui 1993 reported chlorophyll mutations in Vigna radiata L. (Wiczekll). Mutagenic effectiveness and efficiency of chemical mutagens. Mutations were induced in tow Mung bean varieties PS-16 and Pusa Baisakhi, by treating seeds with 0.1 to 0.4 % ethyl methane sulphonate (EMS), 0.01 to 0.4 % Methyl methane sulphonate (MMS) and 0.01 to 0.04 Sodium azide (SA). Three different types of chlorophyll mutants were observed in the M₂ generation; Albina, Chlorina and Virids. Chlorophyll mutation frequency increased with increase in concentration of various mutagens. EMS produced the highest frequency of mutations followed by
MMS and SA. On the basis of their effectiveness, the mutagens were rated in the order MMS >MMS> EMS. Whereas on the basis of their efficiency, the order was EMS >MMS> SA. All three mutagens were effective and efficient at the lower concentration.

Thakur and Sethi 1993 reported characterization and segregation pattern of some macro mutations induced black gram (*Vigna Mungo* L. Hepper). Seeds of CV Mash Kullu 1 were treated with 5, 10, 15, 20, 25 and 30 Kr gamma rays or 8, 10, 15, 20 mm EMS. Variance and normal sits from the segregating progenies were studied through to the M₃ generation and data were recorded for 5 yield components. EMS induced a higher mutation frequency than gamma rays. Twelve mutant forms were identified in the M₂ and M₃ generations. The inheritance pattern in the M₂ and M₃ generations revealed that most of the mutants were conditional by a single recessive gene.

Dutta and Lahri 1993 reported that nitrate reductase (NR) reached maximum activity within three weeks of ontogenetic development of a single leaf of Mung bean followed by a sudden decay. The leaf NR activity was higher at high- N and increased N supply increased the internal availability of NO₃. Comparable activities of NR in the upper leaves were observed. High N showed higher chlorophyll increased up to the flowering stage and there after declined but higher chlorophyll content was found in the successive upper leaves. Soluble protein in the leaf also showed sharp decline after flowering. Results suggested that Mung bean have potential for nitrate assimilation at the early stage and low level of fertilizer N application at the time of sowing might lead to higher yield of Mung bean.

Ignacimuthu 1994 induced protein and isozyme variation in *Vigna*
**radiata** var. PS-16. Electrophoretic variation in protein and east-erase and amylase isoenzymes profiles were investigated in 24 hrs germinated M₃ seeds (obtained from M₂ generation plant of CV PS-16) following treatment with ethyl methane sulphonate or gamma rays. The protein and easterase profiles had a high degree of polymorphism, whereas the amylase profiles showed little variation. Mutagenesis had increased the variation in comparison with controls (Ignacimuthu, 1994).

Patil et al. 1994 indices and values for 20 M₃ selections of green gram. Eleven selection indices were formulated using 3 yield components, which showed positive correlation with yield. Genetic advance and relative efficiency of these indices was determined in the studies with the M₃ of 2 Vigna radiate L. cultivars, PIMS and Pusa Baisakhi, following treatment with gamma radiation or EMS. The index consisting of number of pods, and pod seed yielded per plant showed the highest genetic advance and the highest relative efficiency. The index values were highest for all the selections when the index giving highest genetic advance was considered. Selections derived from EMS treatments generally gave higher index values than selections derived from gamma irradiation in both cultivars.

Garg and Chawla 1994 media and different phytochrome effects have been standardized for callus induction and plant regeneration in cultivars ML-5 and K 851 of Mung bean callus was induced from different explant taken from 4 day old germinated seedlings. Cotyledon explants showed maximum callus induction on PCL-2 media supplement with NAA and BAP. Primary calli derived from leaf expand showed maximum of 22 % in ML 5 and 14 % in K 851 genotype plant regeneration frequency on basal medium supplement with NAA, Zeatin and Methyl cysteine.
Haqqani and Pandey 1994 reported response of mung bean (V. radiata L. Wilczek CV Pagasa-3) to three irrigation schedules, two plant densities (PD) and five moisture regimes was studies in 1987 and 1988. Water Stress decreased seed yield, pod number, no. of seeds per pod, and 1000-seed weight. No. of seeds per pod decreased and no. of pods per M2 increased with PD. High plant density (PD1) treatment. Water use efficiency was highest at PD2, when the crop was irrigated at flowering and seed development stages. Although root water extraction efficiency (RWEE) was greater from the upper soil profile (0-60 cm) in all treatments. RWEE was higher in the 60-100 cm soil profile of dry regimes than that of wet regimes. Increase in yield and yield components were highly correlated with water applied in both years. Seed yield was also positively correlated with leaf area index and per cent ground cover while it was negatively associated with specific leaf weight, leaf water, potential, osmotic potential and root length density. The result of the experiment indicated that mung bean can suffer due to water stress when grown in an upland rice soil and that irrigation at flowering and vegetative plus pod development stages can improve seed-yield. Effective utilization of subsoil moisture can also be exploited efficiently with higher PD.

Jaagetiya and Arey 1994 determined the effect of low an toxic levels of nickel on seed germination, root shoot length and dry weight of Vigna radiata was studied. Though ultimate germination was always 100 % in all these of nickel, the germination speed was found to be highest at 3ug ml - 1Ni dose, Lower dose resulted in an enhancement while higher doses resulted in a decrease in root shoot length and dry weight in the test plants.

Baruch and Tadukar 1994 reported genetic variability and correlation for yield and physiological attributes in micro mutants of green gram (V.
radiata L. Wilczek) - Variability and pattern of association for yield and 8 other yield attributing physiological traits were studied in 34 micro mutants of green gram in M₆ generation along with their two base genotypes, AAV- 34 and AAU - 39 Large extent of genetic variation was exhibited by leaf area/plant, harvest index (HI), biological yield/plant and chlorophyll-b content of leaf. Among this high heritability coupled with high genetic advance was observed for biological yield/plant which also exhibited a strong association with seed yield per plant. A strong negative of seed yield/plant with HI coupled with high genotype coefficient of variation (GCV), heritability and low genetic advance was indicated chlorophyll-b with high GCV further exhibited strong association with biological yield / plant.

Dhandi 1994 investigation were conducted on mung bean (V. radiata L. Wilczek) cv. K-851 asses the degree of control exercised by the availability of current photosynthetates on nitrogen fixing activity of nodules. Forty-five days old plants were subjected to 50 and 100 per cent defoliation treatments. The rates of N₂ are activity Soluble Carbohydrates, starch, Protein and amino acid content of the nodules were estimated at different times. Defoliation of plants resulted in considerable decrease in ARA of nodules. After 90 h of 100 and 50 per cent defoliation, ARA of nodules was 93 and 46 per cent lower than the control, respectively. However, the decline in nodule carbohydrate and starch was not commensurate with decline in ARA. The nodules retained more than 40 per cent of their carbohydrates and 63 per cent of their starch even after 90 h of complete defoliation. The decline in nodule protein was very less, 9 per cent in case of complete defoliation and 7 per cent in case of partial defoliation. Defoliation resulted in an accumulation of amino acids, registering 34 and 29 per cent increase, respectively with complete and partial defoliation treatments.
Twenty-eight F2S of an 8X8 dialleled cross and eight patent of mung bean were evaluated during summer and Kharif season of 1986 at J.N.K.V.V. Research Farm, Jabalpur. Mean squares due to general and specific combining ability were significant for most of the characters in each season and over pooled analysis. ML62 was the best general combiner for seed yield and 100 seed weight with early maturing plant type. P16 was the best general combiner for pods per plant and no. of seeds per pod. Among crosses PS 105xRM 352 followed by seed yield and another component character. Numerical analysis suggested that non-additive gene action played an important role in expression of majority of the characters. Although the additive genetic variance was substantial (Holker and Sunil 1995).

Routary et. al. 1995 studied genetic variability and effectiveness of some chemical mutagens on black gram in relation to resistance source against Meloidogyme incognita seeds of black gram (Vigna mungo L.) CV PH 25 were treated with various chemical mutagens at various doses M₆ plants were evaluated for desirable characteristics in an M incognita infested field of the 40 selected mutant lines tested, only 6 were classed as moderately resistant to the nematode. The mutagenic treatments which were considered the most useful in inducing desirable agronomic characters were ethyl methane sulfate at 0.2 % and Sodium azide at 0.015 %.

Mishra 1995 multivariate analysis of genetic divergence in micro mutants developed from black gram variety T₉. Fifty four induced mutants of black gram (Vigna mungo) line T₉, were developed by single and combined treatment with chemical mutagens (Ethyl methane sulphonate, Sodium azide, N-methyl-N-Nitroso quanidine and Malei C hydrazide) and could be grouped in to 12 genetically diverse clusters using multivariate analysis of data from 7 yield components. Pods / plant, 100 seed weight and plant
height showed high contributions to genetic divergence. The majority of mutants developed using single mutagenic treatments clustered away from the parental cluster. While most of the mutants developed through combined treatments clustered with the parents. Thus, single treatments were, in general, more effective than the same mutagenic treatment often grouped into different clusters indicating each mutagenic treatment was effective in inducing diverse type of changes. Taking $D_2$ values and yield components into consideration, the crosses TS2-1 X TE-2, TS 2-1 X TES2-3, TS2-1 X TEM2-2 and TS2-1 X TS3-3 are expected to produce more high yielding segregants.

Yu-Ming-HO 1996 studied the effect of fluoride on growth and soluble sugars in germinating mung bean (*Vigna radiate* L.) seeds. The influence of NaF on the growth and soluble sugar contents of mung bean (*Vigna radiata* L.) seedling was studied one-day-old seedling were treated with 0, 0.10, 1.0 or 5.00 ml. NaF and 25 % for 72 hrs and the wet weight, root elongation, and soluble sugar levels of the seedling were determined. The weight of the cotyledons was increased while the weight and length of radical was significantly depressed in seedling exposed to NaF at and above 1.0 mM. Total soluble sugars and F concentration. The results suggest that an impaired sugar metabolism may be an important factor contributing to the observed inhibition of germination in Mung bean seedlings exposed.

Sarma and Talukdar 1996 reported causal relationships in micro mutants of green (*Vigna radiata* L. Wilczek). Estimates of correlation coefficients with direct and indirect effects were obtained for seed yield per plant and its component traits in 34M2 V. radiata lines derived by treating seeds of the locally adapted varieties AAV34 and AAV39 with varying doses of ethyl methane sulphonate and gamma rays. Seed yield/plant was
positively correlated with plant height and pods/cluster had the greatest
direct effects on seed yield.

Sugawara, et. al. 1996 reported insecticidal peptide from mung bean.
A resistant factor against infestation with azuki bean weevil. A resistant
factor from a strain (ICI 1996) of wild mung bean (V. radiata Var. Sublobata)
active against the azuki bean Weevil (Callo Sobruchus Chinesis) was
genetically transferred into a susceptible cultivar. The resulting strain (BC20
F4) tolerated an infestation by C. chinensis. The ethanol extract of BC20 F4
inhibited larval growth. Vignatic acid A (1) was isolated and evaluated as one
of the inhibitors present in BC20 F4. Structure 1 was determined to be a
cyclopeptide alkaloid composed of L tyrosine, 3 (s) hydroxyl-L-Leucine, L-
phenyl lanine, and 2 hydrox isocarprioic acid by FAB-HRMS, DQF-FGCOSY,
FG-HMQC and NOGDF. This compound is the first example of an
insecticidal cyclopeptide alkaloid base of plant origin.

Singh 1996 reported that Gamma rays have induced bold seeded
mutant in Vigna mungo (L) Hepper. A vigorous and bold seeded mutant was
isolated from M2 progeny of 20 KR gamma - ray irradiated plant population
of Vigna mungo CV T-9. The mutant had larger leaves and flowers similar to
control but upper part of style and stigma of each flower was curved. The
mutant had larger and healthy Pods bearing bolder seeds and showed
higher seed yield/plant. Cytologically, it showed normal meiosis. The X2 test
showed that the mutation is controlled by a single recessive gene. The
protein content was higher in the mutant while amino acids and trypsin
inhibitor were more are less similar to the control.

Gupta et. al. 1996 producing new mung variety through induced
mutations, 1979, dry seeds of mung bean (Vigna radiata) varieties ML5 and
K 851 (with 9.80 % and 3.53 % moisture content, respectively) were treated with (1) acute doses of gamma rays (200, 400, 600 and 500 Gy), (2) EMS [ethyl methane sulphonate] (0.2 % and 0.4 % for Ghand and 12 h) and (3) gamma rays (100, 300 and 400 Gy) followed by 0.2 % EMS for 6 h. M2 progenies of MLS XK 851 were selected for the following attributes (1) early and synchronous maturity, (2) resistance / tolerance to mung bean yellow mosaic bigemini virus (MYMV) and for (3) higher yield. Some of the mutants with higher number of pods per plant and higher yield were tested in M5 and M6 generations [Mutation Breeding Newsletter (1982) No. 20, 13] Superior mutants were advanced up to the M8 generation. Four promising mutants (MUMI-4) were developed. Preliminary yield trials were conducted for 4 generations, frised during 1983-1989, All mutants out yielded their parents and control varieties Pusa Baisakhi and PS-16 in the summer as well as in the rainy season, except MUM2 in the summer of 1983, and MUM4 in Kharif 1984 and the summer 1985. MUM1, MUM2 and MUM3 were highly tolerant of MYMV and were synchronous in maturity MUM4 was only moderately tolerant, In "Kharif" 1985 the 4 mutants were submitted to the All India coordinated Programme for Pulse improvement for multi location. Initial evaluation, trials. MUM2 and MUM3 were promoted for co-ordinate /advanced variety trials in 1989, 1990 and 1991, MUM2 was released as a variety in the state of Utter Pradesh (for summer) and for the North West Plan in one of India (for Kharif season) 199/1 and 199, respectively.

Mohapatra et. al. 1996 reported efficiency of different mutagenic treatments (combinations of ethyl methane sulphonate (EMS), Sodium azide (SA), N-methyl- N-nitrosovera and gamma radiation were evaluated along with the parental variety. Efficiency of mutagenic treatments was assessed by two methods, both of which were equally effective in distinguishing the
difference among the mutagenic treatments.

Treatments with 0.5 % EMS after 4 hours pre-soaking and 0.05 % Sodium azide at pH5 showed the greatest efficiency in improving yield components.

Mahapatra et. al. 1996 induced efficiency of different mutagenic treatments in green gram. Mutant lines derived from the green gram (*Vigna radiata*) variety ML5 by 13 different mutagenic treatments (Combination of ethyl methane sulphonate (EMS), Sodium azide (SA), N- nitrosoures and gamma radiation ) were evaluated along with the parental variety efficiency of mutagenic treatments was assessed by two methods, both of which were equally effective in distinguishing the differences among the mutagenic treatments. Treatments with 0.5 % EMS after 4 hours pre soaking and 0.05 % SA at pH5 showed the greatest efficiency in improving yield component.

Byregowda et. al. 1997 induced genetic variability and interrelationship aiming yield and yield components in green gram (*Vigna radiata* L.) Twenty-five genotype of green gram were studies for genetic variability and interrelationships among yield and yield components. Sufficient variability was present in the material for grain yield and pods per plant, which was mainly attributed to additive gene action. The significant and positive association of grain yield was observed with pods per plant and seed per pod and 100-seed weight exhibited direct effect on grain yield. Therefore, characters such as pods per plant, seeds per pod and 100-seed weight should be given due to importance while making selection for increased yield in green gram.

Singh and Mahapatra 1997 reported Digitonin as an enhancer of mutagencity of ethyl methane sulphontate in black gram (*Vigna mungo* L.).
In a mutagenic study in black gram (*Vigna mungo*), digitonin (200, 350 and 500 ppm) was applied as a seed pre-treatment before application of ethyl methane sulphonate (EMS) to enhance the uptake of the mutagen into cells. Frequency and spectrum of chlorophyll digitonin-EMS treatment compared to EMS treatment alone. Digitonin pre-treatment also increased mutations in plant height, branches/plant, pods/plant and 100-seeds weight.

Sahu and Batra 1997 produced evaluation of quantitative characteristics in some mutant lies of gram (*Phaseolus radiatus*) seeds of *P. radiatus* (*Vigna radiata*) cultivars Phauli and Sujata were pretreated with thyroxine, digitonin and Colchicine before treatment with 0.2 % solutions of ethyl methane sulphonate and Sodium azide. Seeds were sown in 1986 and M1 to M5 generations selected for variants with higher pod number and desirable agronomic characteristics during 1986-88. A total of mutants were selected and evaluated for 9 yield components during 1988-92 in general estimates. Phenotypic variation was higher than genotype variation. Estimates of heritability were high for all the characters indicating that a major part of the phenotypic variability should be attributed to induced mutations. Genetic gain was low for almost all the characters, indicating low potential for further selections. Among the mutant lines, there were significant increases in pod number and length, and decreases in days to maturity. Overall, OVM11-5 was ranked the best mutant phenotypes, followed by OVM11-2, OVM11-6 and OUM14-1.

Vanniarajan and Das 1997 induced variation for seed protein content in black gram. Dry seeds of black gram (*Vigna mungo*) varieties ADT3 and Vamban 1 were irradiated with 20-100 KR gamma rays. In another experiment, seeds were pre-soaked in water for 16h and treated with 20-100 ml ethyl methane sulphonate for 6h. Data are tabulated on the protein
content of the seed in the M₁ and M₂ generations of both varieties for all mutagenic treatment.

Singh et. al. 1997 induced mutation studies in mung bean (Vigna radiata L Wilczek ). Dry seeds of mung bean CVPS 16 were treated with various doses of gamma rays (20,30 and 40 KR), ethyl methane sulphonate (EMS, 0.05-03 % ) and epichlorohydrin (ECH, 0.4 %) and data on seed germination, seedling survival, Plant, fertility, mitotic index and seedling vigour were recorded in the m₁ generation. There was a linear relationship between doses of these mutagens and decrease in all these parameters. The mutagenic effectiveness increased with an increase in doses of the mutagens used. Among the three mutagens tested, EMS was the most effective and gamma rays the best effective.

Wongpiyasatid et. al. 1998 isolated mutant mung bean lines from radiation and chemical induction. With a view to improving yield and resistance to Cercosora leaf spot and powdery mildew (Erysiphe polygon) with gamma rays (doses of 500 Gy) or soaked in a 1 % ethyl methane sulphonate (EMS) Solution for 4h individual plant and raw selections were made in the M₂ and M₃ generations in KPS1 and in the M₃ kand M₄ generations of CN 36 Five promising mutants were derived from KPS1 via gamma irradiation. M5 -8 with good pod setting M5 -19 with pods protruding up above the canopy; M5-21 and M5 -22 with good plant type and high pod settings; and M5-24 with early flowering. All 5 of these lines possessed moderate to powdery mildew and Cercospora leaf spot.

Sarma 1998 induced variability following single, combined and recurrent doses of EMS and gamma rays in green gram (Vigna radiata L. Wilczels). Seeds of green gram genotypes T- 44, AAV- 34 and AAV- 39
were soaked for 12 hrs. and exposed to 10 Krad gamma rays and treated with 0.1 % ethyl methane sulphonate (EMS) for 6 hrs. Half of the M1 seeds were treated with half the previous does to induce recurrent mutations. Differential response of the genotypes to treatments was observed for all characters. The highest range of variability of the M₂ for various characters was induced by the recurrent treatments followed by single and combined treatments. The recurrent treatments were more effective in changing the near values and inducing additional variability than single and combined treatment. In general gamma rays induced higher mean performance and variability than EMS.

Sahu et. al. 1998 reported stability performance and selection indices of some mutants of green gram (Phaseolus radiatus). Seeds of the green gram (Phasedus radiatus) C.V. Dhauli, the predominantly grown variety in Orissa India were treated with Ethyl methane sulphonate and Sodium azide separately. M₅ mutant lines were evaluated for a number of yield related trials and the 5 most promising lines identified via different selection criteria were evaluated at 5 environments during 1989-92 to study their stability of performance OVM 11-2 was stable and well adopted to all environments and is recommended for general cultivation.

Gautam and Mittal 1998 induced mutations in black gram (Vigna mungo (L) Hepper ). Mutations were induced in black gram (Vigna mungo) CV T0 following Seed treatment with gamma rays (5, 10, 20, 30 and 40 KR ) ethyl methane sulphonate ( EMS, 10,20,30,40 and 50 NM ) and their combinations (EMS at 20 mM only). Ten different types of macro mutants (digitate narrow leafed , giant, bushy, dwarf, horizontal branching, glabrous, vine type , umufoliate, male sterile) and four micro mutants (high pod bearing, early maturing, brown seeded, short podded were recorded in the
Sarma and Talukdar 1999 reported sensitivity of green gram (*Vigna radiata* L Wilczek) to physical and chemical mutagen. Seeds of green gram (*Vigna radiata*) genotypes AAV34 and (EMS) and AAV39 were treated with variable doses of ethyl methane sulphonate (EMS) and gamma rays. Two combined doses of EMS and gamma rays were also used to induce mutations. The M₁, M₂ and M₃ Progenies were raised and date collected on 10 yields related trials. A large amount of genetic variability was observed in the M₂ and M₃ generations of the single mutagen treatment, gamma rays, in general induced higher mean performed and variance than EMS. Mean values and variance of the trials were generally higher after combined treatments with EMS and gamma rays than single mutagenic treatments alone of the 21 micro mutants, selected. On the basis of superior performance 11, were derived from various doses of gamma rays and from combined treatments. A tetra foliate macro mutant detected in the M₂ generation of AAV 39 after treatment with 0.11 EMS to 10 krad gamma rays was also associated with higher yield performance. Another macro mutant with synchronous maturity was detected in the M₃ generation of AAU 34 following the 30 Kr and gamma ray treatments.

Ravikesavan et. al. 1999 studied germination and survival in mutagen treated pulse crops. Seeds of 11 cultivators in mutagen from Pigeon Peas, black gram (*Vigna mungo* L.), green gram (*V. radiate* L.). Bengal gram (*Cicer arietinum* L.) cow pea and Lab (*Lablab purpureus*) were treated with 10-100 methyl methane sulphonate (EMS). Seed germination and survival on 50th day after sowing were studied. With cowpeas CV. Co6, seed germination and survival rate was 790 % at all the concentration of EMS. Relationship between the concentration of EMS and germination was not consistent in all
Khan 1999 studied the mutagenic effectiveness and efficiency of EMS, gamma rays and their combination in black gram (Vigna mungo L. Hepper) Dry seeds of black gram genotypes plant U-19 and T-9 were treated with 0.2, 0.4 and 0.6 % ethyl methane sulphonate (EMS), 150,250, and 350 Gy Gamma radiation and combinations therefore Low doses of Mutagens in general and gamma radiation were more efficient than high doses and EMS and combined treatments in producing chlorophyll mutations.

Mehraj -ud-din et. al. 1999 studied the efficiency and effectiveness of chemical mutagens in mung bean (Vigna radiata (L) Wilczek) using Sodium azide and hydrazine hydrate (HZ). The spectrum of chlorophyll mutations, consisted of Albina, Chlorina, Viresente, Viridis and Xantha. Out of these chlorophyll mutations Xantha type was predominant in both the mutagenic treatments. The frequency and spectrum of chlorophyll mutations as well as mutagenic efficiency and effectiveness was the highest at lower doses. HZ was the most efficient and effective mutagen with respect to the biological damage and high frequency of chlorophyll mutations.

Malik et. al. 1999 reported EMS induced chlorophyll mutations in green gram (Vigna radiata L. Wilczek). The present investigation was undertaken to assess the effectiveness of ethyl methane sulphonate (EMS) in induced chlorophyll mutation in green gram (Vigna radiata (L.) Wilczek). The present investigation was undertaken to assess the effectiveness of ethyl methane sulphonate (EMS) in inducing chlorophyll mutations in four varieties of green gram (V1 B105, LM23 and K851). Four type of chlorophyll mutations (Albina, Xantha, Chlorina and Vinridis) were detected, with Xantha types being most frequent in all varieties. Mutation frequencies differed
between varieties, with EMS inducing a higher frequency of mutations in
K851.

Tickoo and Chandra 1999 mutagen induced polygenic variability in mungbean (Vigna radiata L. Wilczek ) Two varieties of mung bean were treated with ethyl methane sulphonate (EMS) (0.1 and 0.2 %) N-methyl-N-nitrosoures (NMV, 0.01 and 0.02 %, hydroxyl amine (0.06 and 0.07 and gamma rays (30 and 40KR). In the M2 and M3 observations on six characters were recorded for overall variance, interfamily variance and character means. All mutagen doses induced significant in the M2. Plants with desirable attributes were selected from M2 families showing higher CV and mean values than the highest corresponding values from the respective control group of families. Selection in the M2 was effective as mean values in the M3 shifted in positive directions and in the M3 interfamily variances increased over corresponding M2 treatments. In the M3 along with the positive shift of the values, both interfamily and overall variances were still significantly higher than the control values indicating scope for further selection and improvement of characters by polygenic characters, provided large populations are raised and selection procedures are followed.

Singh et. al. 2000 reported the mutagenic effects of gamma rays and EMS on frequency and spectrum of chlorophyll and macro mutations in urbean (Vigna mungo L. Hepper). The mutagenic effects of gamma rays (10, 20, 30 and 40 KRV and ethyl methane sulphonate (0.01,0.02, 0.03 and 0.04M ) alone or in combination ( 10Kr+0.02M, 20 KR+0.02 M, 30 KR+0.02M and 40 KR+0.02M ). On the frequency and spectrum of chlorophyll and macro mutations in the cultivars, PDV1 and T9 were observed. Combination treatments yielded the higher frequency and spectrum of chlorophyll mutations whereas the various doses of mutagenic
agents have independent response towards macro mutations in both the cultivars.

Pawar et. al. 2000. Reported that mutant and its derivatives when used in cross breeding have found to be more productive in the development of improved varieties of black gram. Mutant of breeding value with higher yield and disease resistance.

Waghmare and Mehra 2000 reported that induced chlorophyll mutation in grass pea (Lathyrus stivus L.) The chlorophyll mutant's albino seedling itself has no practical value however; such seedlings may be used as genetic markers for estimation of natural selfing. The phenomenon of albinism is rarely exhibited by plants which characteristic deficiency of chlorophyll and subsequent whitish – yellow colour of entire seedling.

Govindavasu and Ramamoorthi 2000 reported the two season varieties viz., SVPR 1 and Co1 and mutagens viz., gamma rays and EMS. The genetic variability generated in quantitative traits. The capsule length record comparatively higher GCV followed by number of seeds per capsule in both the varieties 1000 seed weight in Co1E and single plant yield in SVPR 1 also registered high GCV %

Waghmare and Mehra 2001 reported that the EMS has been found more effective and efficient than physical mutagen in Lathyrus stivus. Higher mutagenic effectiveness and efficiency was observed in Lathyrus stivus L., at lower doses of EMS than in gamma irradiation treatments.

Rahman et. al. 2001 reported that the EMS was much increases to gamma rays of Black gram. In M₃ generation, significant increase was observed in 0.1 % EMS and 60 KR gamma rays than control and other
dose/concentration of mutagens. Where as, seed protein content was decreased in M₄ generation at all dose/concentration of EMS and gamma rays compared to control. A positive shift of mean value in seed protein content in M₃ generation was observed.

Bhatia et. al. 2001 reported that gram legume cultivars derived from induced mutations and mutations affecting nodulation. The generation of genetic variability by induced mutagenesis provides a base for strengthening plant improvement program. Various classes of physical and chemical mutagens differ in their efficiency in inducing mutations and in the spectrum of mutations induced. Combination of different mutagens. If then mutagen induction process is independent and capable of interaction, should increase the mutation frequency and alter the mutation spectrum while, ionization radiations still remain the most suitable agents for inducing genetic variability.

Wagmare and Mehra 2001. Reported EMS induced chlorophyll mutations in Lathyrus sativus L. Mutagenesis has been widely used as a potent method of enhancing variability for crop improvement. The chlorophyll mutation frequency in M₂ generations is the most dependable for evaluating the genetic effects of mutagenic treatments.

Lee 2002 reported in sweet potato effect of gamma rays, that mutation is sudden heritable change in organism generally of structural change in gene. It is produced by change in the base sequence of genes and it can be induced either spontaneously or artificially both in seed and vegetative propagated crops. Induced mutation or highly effective in enhancing natural genetic resources and have been used in developing improved cultivars of cereals, fruits and other crops.
Ramesh and Reddi 2002 reported that tall and dwarf mutants were observed in different mutagenic treatment in rice among the dose or concentration of maximum number of mutants were recorded at 25 K R of gamma rays.

Soufraianien et. al. 2002 reported that the gamma ray treatment has been employed for the development of 64 % of the mutant varieties in black gram. To date, worldwide, 2252 mutant varieties have been officially registered of which 1585 were released as direct and 667 were mutant derivatives. Mutated genes have therefore; become valuable material to plant breeders and molecular biologists for understanding not only the function but also in isolating and shuffling the genes between varieties.

Deepolokshmi and Ananda 2003 reported that the EMS was much pronounced than gamma rays in Urdbean (Vigna mungo L.) In M₂ generation that EMS, was more pronounced in inducing chlorophyll mutations than gamma rays and among the spectrum , the viridis (less drastic mutations ) was more than that of albino (extreme mutation ).

Wani and Anis 2004 reported EMS induced chlorophyll mutations in cowpea. Some of the chlorophyll mutants Vi3 , albino, chlorine , variegate and xantha in the segregating , M₂ plants based on the intensity of pigmentation at the seedling stage ; mutations in these chlorophyll genes are reflected in the M₂ and subsequent generations in the form of different types of mutants.

Singh and Mahaptra 2004 reported EMS induced chlorophyll mutation in black gram. The present investigation was undertaken to assess the effectiveness of ethyl methane sulphonate (EMS) in inducing chlorophyll mutations in black gram. In M₂ generation that EMS was effective in inducing
chlorophyll mutations than gamma rays and among the spectrum, the viridis was more than that of albino.

Ahloovealia et. al. 2004 reported the use of gamma rays in Euphytica he find out that a great majority of mutant varieties (64 %) were developed by the use of gamma ray. These mutation provide beneficial variation for practical plant breeding purpose. During the fast seven decader, more than 2252 mutant varieties have been officially released in world

Goikvead and Kathekar 2004 reported mutagenic effectiveness and efficiency of EMS and Sodium azide in lentil, EMS have been pound more effective and efficient in Lentil. EMS could be fruitfully applied to develop new varieties with high yield and other improved organic traits.

Solanki et. al. 2005 reported that in M$_2$ generation that EMS was more pronounced in inducing chlorophyll mutation than gamma rays in Lentil (Lens culinaris Medik.). The viridis was more than that of albino. All the spectrum, the viridis has less drastic mutation was more than that of albino has extreme mutation.

Natarajan et. al. 2005 reported that In India still today there as 7 mutant varieties of black gram released by both physical and chemical mutagens.

Solanki I. S. 2005 reported EMS & SA induced chlorophyll mutation in lentil (Lens culinavis Medik. )The present investigation was under taken to assess the effectiveness of ethyl methane Sulphonate (EMS) in induced chlorophyll mutation in Lentil (Lens culinavis Medik.) The present investigation was under taken to assess of effectiveness of ethyl methane sulphonate (EMS) in inducing chlorophyll mutations in Lentil. The chlorophyll
mutants. Albino, chlorine and xantha mutants in lentil with effect of EMS and SA while, EMS was found almost twice as efficient as SA. The highest mutation frequency was noted in EMS (1.0 %) than other dose/concentration of mutagens. Bushy, prostrate tending, tall, dwarf early maturity and sterile mutants were more in EMS than SA in M2 generation.

Khatri et. al. 2005 reported high yielding mutants of Brassica juncea cv 5-9 develop through gamma rays and EMS. The gamma rays and EMS could be fruitfully applied to develop new varieties with high yield and other improved organic traits. EMS has been found more effective and efficient than physical mutagens in crops like cow pea.

Ahalya et. al. 2005 reported in Bengal gram (cicer arietinum), the removal of 99.9 % of chromium in the 10 mg/l chromium solution, the biomass required at saturation was 1 g mg -1 . The biosorptive capacity of the (bgh) was dependent on of pH of the chromium solution, with pH 2 being optimal. The absorption capacity increased with increase in agitation speed and an optimum was achieved as 120 rpm. The biosorption of Cr (VI) ions in the biomass affects of bands corresponding characterization of parameters indicates bgh to be an excellent material for biosorption of Cr (VI) to treat various waters containing low concentration of the metal.

Kouser 2006 reported that in cicer arietinum L. the three mutagens i.e, gamma rays, EMS & SA were found to be more effective at lower concentration /dose. The decline in the mutagenic effectiveness recorded at higher doses shows that the increase in mutation rate was not proportional to the increase in two doses of various mutagens.

Turkan et.al. 2006 reported in four per mutagenic effects of NaN3 on M1 generation. LD 50 results showed that 0.001 M NaN3 was most
appropriate for the certain of mutagenesis and was not highly lethal. Seeds treated with 0.001 M NaN₃ grown on MS medium containing various concentrations of BAP and TDZ showed that BAP with NaN₃ was better compared to TDZ with NaN₃. Although on effect of mutagen NaN₃ was observed on rooting, purence of BAP or TDZ in the medium.

Shah et. al. 2006 reported in M₁ generation that EMS was more pronounced in inducing chlorophyll mutation than gamma rays in chickpea (Cicer arietinum L.). The maximum chlorophyll and viable mutation frequency of EMS. While of minimum chlorophyll and viable mutation frequency of gamma rays.

Velce et. al. 2007 reported that in cluster bean (Cyamopsis tetragonoloba) the effectiveness and Efficiency of gamma rays and EMS, The seedling height reduction in different M₁ generation. The biological damage (Lethality / injury) was computed as the reduction in plant survived and plant height.

Dhanavel et. al. 2008 reported that the effect of EMS treatment on the germination and survival percentage decreased with increasing dose/concentration and a field condition was observed in M₁ generation in Cow pea (vigna ungviculata L. walp) They further reported that the growing condition of the next generation also affect germination, seed yield and mutation rate.

Sidramappa et. al. 2008 reported in chickpea correlation and path coefficients for ten characters. Seed yield had a high positive correlation with pods per plant (0.779), plant height (0.637). Number of branches (0.538). 100 Seed weight (0.34), reproductive period (0.342) and days to maturity 0.327. The path coefficient and analysis revealed that number of pods pen plant
has highest direct effect (0.766) on seed yield. The characters number of pods per plant, 100 seed weight, plant height and reproductive period should be taken into consideration in breeding of high yielding gram varieties.

Shah et. al. 2008 Comparative mutagenic effectiveness and efficiency of gamma rays and Ethyl methane sulphonate (EMS) were studied in to desi (Pb 2000 and C 44) one kabuli (Pb I) and one desi x kabuli introgression line (CH40/91) of chickpea. The treatment included two doses each of gamma rays and EMS calculated on the basis of their LD3. The results revealed EMS was almost seven times more effective and its efficiency was two times higher than that of gamma rays. Mutagenic effectiveness and efficiency was found to depend upon mutagen type and the genotype and both were higher at lower doses of EMS in three genotype except in desi genotype C-44. The overall trend of mutagenic effectiveness and efficiency in both gamma radiation and EMS was in the order i.e. CH 40/91 > Pb 2000 > Pb I > C 44. The introgression line desi x kabuli genotype was found to be most resistant to hoards mutagenic treatment than desi and kabuli types.

Gour. et. al. 2008 reported that in chickpea (Cicer arietinum L.), the root length density (RLD) in the relatively shallow soil layers and the maximum root depth (RDP) positively influence the seed yield under terminal drought environment. The number of root traits including root biomass, RLD and RDP. A few germ plasm accessions identified more prolific root system than the previously identified germ plasm Line ICC 4958. The best known source of high root biomass.

Ashoka 2008 studied the effect of micronutrients with or without organic manures on yield of Baby corn – chickpea sequence during 2005-06. The application of RDF (150:75:40Kg N, P2O5 K2O ha-1) + 25Kg Zn
So4 +10 Kg Fe So4 +35Kg Vermi compost recorded significantly higher yield and yield components viz; ear length (7.40cm), ear girth (4.99cm), ear weight (17.40g), yield (64.43qha-1) and green fodder yield (232.33qha-1). The application of 50 % (12.5:25:12.5Kg N1 P2 05 K2 0 ha-1). RDF to chickpea also increased yield attributes and yield viz., pods per plant (100.33), test weight (24.80g) and seed yield (15.4qha-1).

Ali 2008 reported in chickpea blight caused by Ascochyta robiei is one of the major diseases in Pakistan and other chickpea growing regions of the world. Different QTLs par resistance against the fungus have been identified in both inter and intra specific crosses and as located on Linkage Group (LG) 2, 4a, 4b and 6. The screening SSR, SCAR, ISSK and RAPD techniques have been tried to detect the reported QTLs in 21 mutants / Local genotypes. The revealed that QTL, Linked with STMS, RAPD and ISSR markers on LG2, 4a and 6 one not involved in conferring resistance in local genotypes. Other important QTL 4b is saturated with RAPD. SCAR and STMS markers and local genotypes showed strong linkage of STMS and SCAR markers with plight resistance on this linkage group.

Sidramakpa et. al. 2008 reported in Chickpea highly significant variation par yield and other component traits. The important traits like seed weight, pods per plant and seed yield per plant. Heritable variation was high in respect of seed weight (92.60) compared to pods per plant (74.10) and seed yield per plant (79.90). High variability followed by high estimated of heritability observed for pods per plant, seed yield per plant, seed weight, days to 50 % flowering, days to pod initiation and plant height.

Girija and Dhanavel 2009 mutagenic effectiveness and efficiency of gamma rays, EMS and their combined treatments were studied in the
genotype of cowpea variety Co 7. The mutagenic treatments seeds were tested for lethal dose 50 per cent for all mutagens, separately and the dose at which 50 per cent of the seed germination was considered as LD50 values. Gamma rays, EMS and combined mutagens are produced a high frequency as well as a wide spectrum of mutation. The frequency of mutation was more in combined treatments than gamma rays and EMS. The mutagenic effectiveness and efficiency was calculated based on biological damage. In M₁ generation based on seed lethality (L) and seedling injury (I) and M₂ generation was carefully screened for various chlorophyll and viable mutations. Mutagenic effectiveness and efficiency increased with the decreased in dose or concentration. In the present study EMS was provide to be more effective and efficient in causing mutations as compared to gamma rays and the combined treatment.

Goyal et. al. 2009 a comparative study on mutagenic effectiveness and efficiency of two chemical mutagens (EMS and SA) and one physical (gamma rays) mutagen was carried out on two varieties (K-851 and Ps- 16) of mum bean. Gamma rays were found the most potent. While SA was least efficient mutagen and gamma rays showed least effectiveness.

Arulbalachandran and Mullainathan 2009 improve the quantity and quality (methionine) of protein of black gram (Vigna mungo L.) through the mutation using physical gamma rays and chemical EMS in M₂, M₃ and M₄ generation. The protein and methionine content were estimated through the induced genetic effects by the mutagens. Some level of improvement in protein content in 0.1 % EMS and 60 KR of gamma rays.

Thilagavothi and Muallainathan 2009 the frequency and spectrum of macro mutants along with the mutagenic effectiveness and efficiency of different dose/
concentration of gamma rays and EMS in Black gram variety (Vamban-1). The seeds were treated with gamma rays and EMS. The biological damage was calculated in M1 and M2 generation based on lethality (L) and seedling injury (I). In the genotypes number of chlorophyll mutants and viable mutants with effectiveness and efficiency were observed, mutagenic effectiveness and efficiency was calculated based on the biological damage of both generation in chlorophyll mutants and viable mutants. In general the mutation frequency was high on M1 plant than M2 plant for both the mutagens. The spectrum of chlorophyll mutants and viable mutants in M1 and M2 generations. The mutagenic effectiveness decreased with the increased in dose/concentration of mutagen. Mutagenic efficiency increased at lower dose /concentration and decreased with higher concentration.

Arunalachandran et al. 2009 treated in to the Black gram (vigna mungo (L) Hepper), the chlorophyll mutants were observed in to different dose/concentration of gamma rays they were chlorine albino, xantho and viridis. The effect of dose/concentration of mutagens and mutants were, dwarf, till, tiny leaves, hairy leaves, male sterility, brown seed, early, maturing, long pod, bottom and top branching mutant were observed in M2 generation.

Wani 2009 reported that the effectiveness and efficiency of gamma rays, EMS in chickpea two varieties of seeds. In M1 generation based on seed lethality (L), seedling injury (I) pollen sterility (S) and meiotic aberrations (M). The M2 population, screened for various chlorophyll mutations, mutagenic effectiveness increased with the increase in dose/treatment. Combination treatment in general proved to be more effective followed by individual treatments of EMS and gamma rays. The order of efficiency gamma rays+EMS>EMS> gamma rays. The two varieties, var. Pusa-372 proved to be more sensitive to mutagenic treatment than the var. Pusa – 212.