VIABLE MUTATIONS IN M₂, M₃, AND M₄ GENERATIONS IN LABLAB PURPUREUS (L.) SWEET

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ABSTRACT

In the present investigation the viable mutations in M₂, M₃ and M₄ generations of Lablab purpureus (L.) Sweet studied. On the basis of the morphological characterization of viable mutants in M₄ generation the important viable mutants like Tall mutant, Dwarf mutant, Luxuriant mutant, Dark green leaf mutant, Spreading mutant, Early flowering mutant and Late flowering mutant were observed.

The data of the five quantitative characters like 1) Plant height 2) Length of pod 3) Number of pods per plant 4) Number of seeds per pod and 5) 100 Seed weight was collected for the further statistical analysis. The mutagens like EMS and Gamma rays have successfully induced genetic variability in different mutants. The mutants like Dark green leaves, Spreading and Luxuriant was observed highest yield in contributing parameters and even more protein and carbohydrate content as compared to control.

Key Words: EMS and Gamma rays, viable mutants,

Introduction

Lablab purpureus is well known for its physiological diversity and exhibit both bush and twining growth habits, early and late flowering characteristics. More than 3000 accessions of germplasm have been collected worldwide. Despite the diversity the two varieties Rongai and Highworth (Forage varieties) most popular in the U.S. The Rongai (Late flowering) grows upright and has white flowers that blooms when there is less than 11 hours of daylight (FAO,2012). Highworth (early flowering) which is a twining variety that has purple blooms.

Seed Production:

Grain maturation on forage cultivars is not uniform but crops have more synchronous maturity. High grain yields of 1-2.5 t/ha depending on the cultivar. In mixed cropping the grain yields of 0.5 t/ha. Late seedling varieties affected by early frosts. There are some evidences that the light colored seeds have
poor storage potential which affects seedling vigour and establishment.

**Pulses production in India:**
India is one of the major producer and consumer of the pulses in the world. The total 29% of the area is under cultivation of the pulses with the 19% of the total production of the world. India is also the largest importer and processor of the pulses in the world.

**As Commercial crop:**
*Lablab purpureus* is grown as a pulse crop in Africa, Asia and Caribbean. It is also consumed as a green vegetable as its tender pods and leaves are high in nutrients. Compared to other crops it is low in yield therefore it is cultivated as garden crop or mixed crop. Protein from the Dolichos bean can be used as a food additive.

**As Forage crop:** *Lablab purpureus* is used as forage and hay. The leaves are edible as fodder and seeds moderately edible. It is one of the most palatable legumes for animals.

**As green manure:** *Lablab purpureus* is used as a green manure to improve soil quality as it possesses nitrogen fixing characteristic. It often produces more dry matter than cowpea (*Vigna unguiculata*). It produces nitrogen through fixation and returns nitrogen through leaf decay.

**Nutrient contents:**
There is considerable variation in the composition of the pods and the seeds of the Dolichos bean according to cultivar, climatic conditions and the standard of crop management. The proportion of seed to pod-husk is approximately 1.1:1. The approximate composition of the immature pods has been given as: moisture-82.4%; protein-4.5%; fat-0.1%; fibre-2%; carbohydrate-10%; ash-1%; calcium-0.05%; phosphorus-0.06%; iron-10 mg / 100g and nicotinic acid-0.8 mg / 100g; Vitamin C: uncooked samples-0.77-1.12 mg / 100 g and cooked samples-7.33-10.26 mg / 100 g., 4%; carbohydrate- 60.1 % ; ash-3.2%; calcium-0.06%; phosphorus-0.45%; iron-2 mg /100g and nicotinic acid-1.8 mg / 100 g. The chief protein is a globulin and *Dolichosin*. The amino acid content (mg / g N) has been reported as: isolencine-256, leucine-436, lycine-36, methionine-36, cystine-57, phenyl alanine-299, tyrosine-197, threonine-207, valine-294, arginine-393, histidine-186, alanine-266, aspartic acid-727, glutamic acid-978, proline-288 and serine.

The Dolichos bean is a rich source of catechol oxidase. The presence of a cyanogenic glycoside has been reported in certain cultivars.

**Induced mutation in India:**
Physical availability and economic accessibility of food is very important for the food security. The Induced mutation play very important role in the increasing the world food productivity and solve the food crisis.

Total 343 mutant cultivars of the crop plants belonging to the 56 species approved by the authority in India for the cultivation. Out of 343 mutant varieties 119 varieties were belongs to the ornamentals, followed by the Legumes (85) and Cereals (74).

**Review of Literature**
Lablab purpureus is one of the most ancient cultivated crop in the world tolerant to drought and salinity widely distributed in tropical and subtropical regions. During last seventy years more than 2600 mutant varieties developed using various chemical mutagens and physical radiations\textsuperscript{4-15}. Gamma Radio sensitivity determination was assessed in Kenya\textsuperscript{16}. The genetic diversity of the 39 genotypes of the Lablab bean was assess by using RAPD, ISSR, and SSR marker\textsuperscript{41}. The effect of Gamma radiation and EMS mutagens on Lablab purpureus (L.)Sweet Var typicus Cv. CO (GB)14 was studied. The effect of different concentration and doses of the mutagens on the germination of the seeds, survival of plants, chlorophyll mutation, effectiveness and efficiency of the mutagens, agronomic traits studied\textsuperscript{29-34}. Cytomorphological studies in induction of Polyploidy of Lablab purpureus (L.)Sweet Var. typicus investigated to produce different polyploidy\textsuperscript{10}. Mutagenicity of Argemone mexicana oil compared with the alkylating agent DES shows the increased in Pollen sterility and decreased in the survival of plants\textsuperscript{58}.

Material and Methods

Experimental Genotype

The Experimental genotype selected for the present investigation was Dolichos bean Lablab purpureus .L (Sweet). It is commonly known as a Wal in Marathi. The experimental seed material was collected from College of Agriculture, MPKV, Shivajinagar, Pune, Maharashtra, India.

Mutagens used

1. Physical Mutagens Used- Gamma rays
2. Chemical Mutagen-Ethyl methanesulphonate and 3. Combination of the Gamma rays and Ethyl methanesulphonate

1. Physical Mutagen: Gamma Rays:

Physical mutagen can induce mutations in plants derived directly from the discoveries of the X-Rays by (Roentgen; 1895). In addition to the ionizing radiations, the other commonly used physical mutagens are the high energy ionizing particles, alpha (α) and beta (β) particles and neutrons. The mutagenic of these agents derives from a combination of their ability to produce dimmers and reactive ions which in turn cause damage to living organisms.

2. Chemical Mutagens: Ethyl Methanesulphonate:

EMS is an Mutagenic, teratonic and carcinogenic organic compound with molecular formula CH\textsubscript{3}SO\textsubscript{3}C\textsubscript{2}H\textsubscript{5}. It produces random mutations in genetic material by nucleotide substitution particularly by guanine alkylation. It can be induced mutations at a rate of 5×10\textsuperscript{-4} to 5×10\textsuperscript{-2} per gene without substantial killing. The ethyl group of EMS reacts with quinine in DNA, forming the abnormal base o-6 –methylquanine.

Mode of the Mutagenic Treatment:

1. Gamma rays:

Healthy and uniform size of dry seeds of the Dolichos bean variety Phule suruchi were packed in
the polyethylene bags and sealed for the Gamma radiation. Electromagnetic ionizing radiations were applied from CO\textsuperscript{60} source of irradiation. Gamma radiation was carried out at Nuclear Chemistry Division, Department of Chemistry, SPPU, Ganeshkhind, Pune 411007. The seed samples were exposed to doses of 100Gy, 200Gy, 300Gy, and 400Gy of Gamma rays.

2. Ethyl Methanesulphonate (EMS)

Ethyl Methanesulphonate (EMS) was obtained from Spectrochem. Pvt. Ltd. Mumbai (India) with a molecular weight 124.16 g/mol and its density 1.20g/cm\textsuperscript{3} to determine the lethal dose (LD\textsubscript{50}) at suitable concentration of mutagen for the further study. Chemical mutagenic treatments were administered at room temperature at 25±2\textdegree C. Healthy and dry seeds of the Dolichos bean variety \textit{Phule suruchi} having uniform size were selected for the treatment. Seeds were surface sterilized with 0.1% mercuric chloride solution for about one to two minutes then washed thoroughly and soaked in distilled water for 6 hours for pre–soaking of the seeds, which were made the seed coat permeable for the mutagenic treatment.

The aqueous solution of the mutagen was prepared prior to the treatments. The different concentrations used for the chemical mutagenic treatment were 10mM, 20mM, 30mM, and 40mM. After the pre soaking seeds were immersed in the mutagenic solution for the four hours with the continuous shaking. The volume of the chemical solution used was five times more than of the seeds to facilitate uniform absorption. Seeds soaked in distilled water for 6 hours served as a control. Immediately after the completion of the treatment, the seeds were washed thoroughly under running tap water for 3 to 4 times. The seeds later on kept for post –soaking in distilled water for 4 Hours.

500 seeds were used for the each treatment. Out of 500 seeds, 100 seeds from each treatment were plotted between the folds of the filter paper and kept in the dark room at room temperature. It is used to record the germination percentage and seedling injury. Another slot of 100 seeds were kept in the filter paper and germinated in the petriplates after three days to raise the root tips required for the study of the cytological preparation like the mitotic index and screening of the chromosomal abnormalities. The remaining 300 seeds of each treatment along with the control were sown in field by Complete Randomized Block Design (CRBD) with three replications to raise the M\textsubscript{1} generation plants.

3. Combination treatment:

For the combination treatment Gamma rays irradiated seed samples were used. After the Physical mutagenic treatment, chemical mutagenic treatment of EMS was conducted on the seed samples. In the combination treatment Gamma rays and EMS mutagens used like 100Gy+40mM, 200Gy+30mM, 300Gy+20mM, and 400Gy+10mM. For each treatment 500 seeds was used. From each treatment 100 seeds were plotted between the folds of filter paper and kept in dark at room temperature, which was used to record the germination percentage and seedling injury. Another 100 seeds were kept in filter paper and
germinated in petri plates after three days to raise the root tips required to study cytological preparations for the mitotic index and screening of chromosomal abnormalities. The remaining slots of 300 seeds of each treatment along with the control (untreated seeds) were sown in field by Complete Randomized Block Design (CRBD) with three replications in order to raise the M₁ generations.

In M₂, M₃ and M₄ Generation:
Macro mutations (Viable mutations)
Mutations can be scored phenotypical and which affect the morphological characters of the plant were considered as a macro mutations. They were scored during the life span of the plant in M₂, M₃ and M₄ generations. All such plants were harvested and collected seeds separately in M₂, M₃ and M₄ generations.

Statistical Analysis
Statistical data was analyzed using following formulae.

Mean = \[ \frac{\sum X}{N} \]

Variance = \[ \frac{\sum X^2}{N} \]

Standard deviation = \[ \frac{\sqrt{N}}{\sqrt{\text{Variance}}} \]

Standard error (SE) = \[ \frac{\text{S.D}}{\sqrt{N}} \]

Coefficient of variation (CV) = \[ \frac{\text{S.D}}{\text{Mean}} \times 100 \]

Critical difference (CD) = SE (d) \times t \text{ e.d.f.} (Error degree of freedom)

Where, SE (d) = SE (difference) = SE (Mean) \times 2

The ANNOVA was calculated as per method given by (Panse and Sukhatme; 1976)

Following abbreviations were used
- S.V = Source of variation
- D.F = Degree of freedom
- S.S = Sum of squares
- M.S.S = Mean sum of square
- F = Test value

Experimental Observations
The Experimental results recorded in the present investigation on “Induction of genetic variation Lablab purpureus (L) Sweet (Dolichos bean) by physical and chemical mutagens.” in variety Phule suruchi.

M₄ Generation
Macro mutations play an important role to assess the effect of mutagenic treatment. In the present investigation all three mutagenic treatments were succeeded in inducing the macro mutations in Dolichos bean. The Morphological characterization of viable mutants was carried out at M₄ generation used...
by the EMS, Gamma rays and Combination treatment. The important viable mutants discussed below.

1. Dwarf Mutant
This mutant was characterized by an extreme reduction in plant height. It has height in the range of 30 to 45 cm, as compared to control with 60 to 68 cm. Number of pods per plant were 30 to 34, length of the pod were 8 to 8.9 cm. Seeds per pod were 2 to 5 and 100 seeds weight was 35.6 to 36.9 gm.

2. Tall Mutant
Tall mutant showed the height in the range of 72 cm to 81 cm. Number of pods per plant was in range of 34 to 41, length of the pod varied in the range 8.5 to 11.5 cm and seeds per pod were 3 to 6, weight of 100 seeds range was 35.9 to 38.4 gm.

3. Luxuriant mutant
These mutants were found with luxuriant growth. Luxuriant mutant attained height in the range from 67 to 79 cm and number of pods per plant were 39 to 49, length of pod were 9.0 to 11.8 cm, seed per pod were 2 to 6 and weight of 100 seeds range from 35.9 to 38.8 gm. All quantitative characters showed quite good and satisfactory result as compared to control.

4. Dark Green leaf Mutant
The mutant was characterized with dark green leaves. In dark green leaves mutant height ranged from 65 to 76 cm and number of pod per plant was 37 to 44, length of pod was 9.5 to 12.5 cm and weight of 100 seed ranged from 36.7 to 38.9 gm.

5. Spreading Mutant
The spreading mutant showed the height of 69 to 78 cm. The number of pods was in the range of 42 to 62 and length of pod was in the range of 9.2 to 13.5 cm and seeds per pod ranged from 3-7 and weight of 100 seeds ranged from 37.5 to 39.2 gm.

6. Early flowering mutant
The main character of this mutant was early flowering after 45-50 days of sown. The height of the plant was ranged from 63 to 69 cm and pods per plant 30 to 38 and seeds per pod were 3 to 5, weight of 100 seeds was ranged from 36.3 to 38.4 gm.

7. Late flowering mutant:
Commencement of flowering in mutant was found in 70-80 days as compared to control plants of flowering in 60-70 days. The height of plant ranges from 64 to 69 cm and number of pods per plant were 3 to 5, length of the pod 9.2 to 10.0 cm and seeds per pod were 30 to 41 and 100 seeds weight ranges from 36.2 to 37.8 gm.

Quantitative character in M2, M3 and M4 Generation (Table No.1)

In the present investigation the data about the plant height, length of the pods, number of seeds in the pods, number of pods per plant and weight of 100 seeds in M2, M3 and M4 generation were collected and assessment of the quantitative characters has been done.

1. Plant height:

It was found that all mutagenic treatments induced the variability in the plant height. The mean value for control was 67.33-70.66 cm. The maximum height of the plant was recorded 80 cm at 10 mM treatment in M4 generation of EMS. The maximum shift of mean 11.34 cm was observed at 10 mM
concentration of EMS in M$_3$ generation. The maximum coefficient of variation was recorded 2.44 at the EMS treatment in M$_2$ generation.

2. Number of pods per plant:

The range of the number of pods per plant was 39-41 in control for M$_2$, M$_3$, M$_4$ generations. Number of pods per plant indicated that shift in positive direction for all mutagenic treatment in all the three generations. The maximum numbers of pods mean 49.33 were observed at 200Gy+30mM treatment in M$_2$ generation. The maximum shift of mean 10.33 was observed at 200Gy+30mM treatment at M$_3$ generation. The Maximum coefficient of variation was observed 3.73 at Gamma rays in M$_3$ generations.

3. Length of Pod:

The mean pod length in the control was 8.6-9.43 cm. All mutagenic treatment showed positive shift in mean in M$_2$, M$_3$ and M$_4$ generations of Dolichos bean. At the concentration 20 mM EMS treatment, length of the pod 10.20 cm was observed in the M$_1$ generation which was highest value for the mean pod length. The maximum shift in mean 1.03 was observed in 100Gy+40mM treatment.

4. Number of seeds per pod:

The mean value for the number of seeds was 4.6-5. The average 5.33 maximum number of seeds per pod were observed in 10 and 20 mM EMS, 300Gy Gamma radiation and 100+40mM of Combination treatment. The maximum shift of mean 1.0 was observed at the 10mM and 100Gy Gamma rays radiation. The highest coefficient of variation was 13.55 observed at the EMS treatment in M$_3$ generation.

5. 100 seed weight:

The mean of seed weight in control was range from 26.13-26.8gm. The maximum weight for 100 seeds was recorded 28.33 in 10mM EMS concentration at M$_3$ generation. The maximum shift of mean was 1.9 gm which was recorded in the 20mM EMS concentration at M$_4$ generation. The maximum coefficient of variation 1.52 was observed at the Gamma rays radiation in M$_4$ generation.

<table>
<thead>
<tr>
<th>Mutants</th>
<th>Plant Height</th>
<th>No. of Branches per plant</th>
<th>No. of Pods per plant</th>
<th>Length of Pod (cm.)</th>
<th>No. of Seeds per pod</th>
<th>Weight of 100 seeds (gms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>60-68</td>
<td>5-10</td>
<td>38</td>
<td>8.0-10.8</td>
<td>2-5</td>
<td>35.5-36.5</td>
</tr>
<tr>
<td>Dwarf Mutant</td>
<td>30-45</td>
<td>2-4</td>
<td>30-34</td>
<td>8.0-8.9</td>
<td>2-5</td>
<td>35.6-36.9</td>
</tr>
<tr>
<td>Tall Mutant</td>
<td>72-81</td>
<td>7-12</td>
<td>34-41</td>
<td>8.5-11.5</td>
<td>3-6</td>
<td>35.9-38.4</td>
</tr>
<tr>
<td>Luxuriant mutant</td>
<td>67-79</td>
<td>7-15</td>
<td>39-49</td>
<td>9-11.8</td>
<td>2-6</td>
<td>35.9-38.8</td>
</tr>
<tr>
<td>Dark Green leaf Mutant</td>
<td>65-76</td>
<td>7-10</td>
<td>37-44</td>
<td>9.5-12.5</td>
<td>3-7</td>
<td>36.7-38.9</td>
</tr>
<tr>
<td>Spreading Mutant</td>
<td>69-78</td>
<td>6-13</td>
<td>42-62</td>
<td>9.2-13.5</td>
<td>3-7</td>
<td>37.5-39.2</td>
</tr>
<tr>
<td>Early flowering</td>
<td>63-69</td>
<td>5-8</td>
<td>30-38</td>
<td>9.0-11.5</td>
<td>3-5</td>
<td>36.3-38.4</td>
</tr>
</tbody>
</table>

Table No-1 Mean Quantitative characters of the Mutants of *Lablab purpureus* (L.)Sweet
Results and Discussion:

Viable mutations in M₂, M₃, and M₄ Generations

In the present investigation the viable mutations in M₂, M₃ and M₄ generations of *Lablab purpureus* (L.) Sweet on the basis of the morphological characterization of viable mutants in M₄ generation the important viable mutants like Tall mutant, Dwarf mutant, Luxuriant mutant, Dark green leaf mutant, Spreading mutant, Early flowering mutant and Late flowering mutant were observed.

In M₂ generation frequency of the viable mutants increased with increases in the dose or concentration of all the three mutagenic treatments. All the mutagenic treatments show the fluctuation in the induction of the viable mutants. In the present investigation the shiny brown and light brown colour seed coat were observed in *Lablab purpureus* (L.)Sweet as compared to the control with cream coloured seed coat. Bold seed, Shiny seed coat, Dark red seed coat, Cream seed coat, Wrinkled seed coat were reported in *Phaseolus vulgaris* L. by the induction of Gamma radiation treatment²⁹. Shiny seed coat is one of the rare case of the dominant mutations conditioned by the single dominant gene, as it has been estimated that the 99% mutations are recessive¹³. Large number of seed coat colour like brown, dark green, yellowish green and black coat colour were observed with different doses of Gamma radiation and different concentrations of EMS and SA treatments in Mungbean². The similar observations were reported in *Vigna unguiculata*²⁷.

Quantitative characters in M₂, M₃ and M₄ Generations:

The quantitative characters exhibit the continuous distribution as the characters controlled by the polygene and the expressions are affected due to the environmental influences. The genetic variability present in the species which important for the improvement of the cultivated plant. The mutagenesis enhances the natural population and increase the genetic variability of the plant.

In the present investigation the data of the five quantitative characters like 1) Plant height 2) Length of pod 3) Number of pods per plant 4) Number of seeds per pod and 5) 100 Seed weight was collected for the further statistical analysis. The statistical analysis gives information about the character wise genetic improvement of plant through the mutagenesis experiment table ¹. These characters are yield contributing traits. Many researchers have studied the various quantitative characters in the different plants like Soyabean, and Mung bean¹⁷,¹⁸,¹⁹,⁵⁶. All these researchers have noted that mean values for the quantitative characters was reduced, enhanced or equal to that of control in all the mutagen treated

<table>
<thead>
<tr>
<th>mutant</th>
<th>64-69</th>
<th>5-9</th>
<th>30-41</th>
<th>9.2-10.0</th>
<th>3-5</th>
<th>36.2-37.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late flowering mutant</td>
<td></td>
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</table>
populations. Positive shift in mean value of the quantitative characters at the low concentration of the chemical mutagens in Mungbean\textsuperscript{17,46}. The mutagenic effect of the Sodium Azide in increased the variability within the cultivars of the \textit{Cicer arietinum} L were studied\textsuperscript{26}. The different quantitative characters like plant height, days to flowering, days to maturity, number of pods per plant, number of seeds per plant, 100 seed weight were observed. The biological factors like pollen sterility, genetic and physiological imbalance and environmental effect have been indicated for the possibilities factors in shifting the mean values for the production of the quantitative characters in the positive direction. The polygenic mutations occur at random and not in any particular direction\textsuperscript{1}. The positive and negative shift of mean for the various traits in the different mutagenic treated population were reported in different crops like Soyabean\textsuperscript{3}, Wingbean\textsuperscript{14}, Alfalfa\textsuperscript{36}, Cluster bean\textsuperscript{47}, Cowpea\textsuperscript{12} and in Grasspea\textsuperscript{39}.

The variance in M\textsubscript{1}, M\textsubscript{2} and M\textsubscript{3} generations was increased in the majority of all the mutagenic treatments. The increased in the variability in quantitatively inherited characters in different mutagenic population was recorded in Mungbean\textsuperscript{9} and Soyabean\textsuperscript{38}. In the present investigation the significant shift of mean in positive direction was observed in many quantitative parameters such as length of pod with 40mM EMS in M\textsubscript{2}, 100Gy+40mM combination in M\textsubscript{3}, and 200Gy+30mM combination treatment in M\textsubscript{4} generation. The number of pods with 20mM EMS in M\textsubscript{2}, 200Gy+30mM combination treatment in M\textsubscript{3} and 20mM EMS treatment in M\textsubscript{4} generation. The number of seeds per pod with 10mM EMS,100Gy Gamma rays treatment in M\textsubscript{3}, and 100Gy+40mM of combination treatment in M\textsubscript{4} generation. The 30mM EMS and 400Gy+10mM combination treatment shows the negative shift in the mean value.

The plant height significant shift of mean in positive direction was observed in 20mM EMS at M\textsubscript{2}, 10mM EMS at M\textsubscript{3} and 10mM EMS, 100Gy, 200Gy Gamma rays treatment at the M\textsubscript{4} generation. The weight of the 100 seeds shift of mean with 20mM EMS at M\textsubscript{2}, 10mM EMS at M\textsubscript{3} and 20mM EMS at M\textsubscript{4} generation.

The quantitative characters of the different plants were studied by the many plant breeders. In French bean wide variability of the yield parameters were studied\textsuperscript{49}. The quantitative characters such as pod weight, pod length, and yield of pod per plant and number of pods per plant was studied in Cowpea\textsuperscript{57}. High heritability for vegetative pod yield and pod weight in Cowpea were reported\textsuperscript{41}. The high heritability for number of pods per plant and pod length was reported in Cowpea\textsuperscript{55}. The wide range of quantitative characters like number of secondary branches per plant, number of pods per plant, plant height, seed yield per plant, 100 seed weight, seed yield per hectare was reported by in Cowpea. The quantitative characters like number of dry pod weight, plant height, number of pods per plant, seed yield per plant, 100 seed weight, number of seed per pod, length of pod, and cluster per plant in Alfalfa\textsuperscript{36}. The existence of the greater magnitude of variability in the characters developed through the selection of the varieties.

The similar results were reported in Wingbean\textsuperscript{14}, Alfalfa\textsuperscript{36}, Clusterbean\textsuperscript{47}, Cowpea\textsuperscript{12}, Guar\textsuperscript{53}, Grasspea\textsuperscript{60}, Mungbean\textsuperscript{50}, Chickpea\textsuperscript{22}, French bean\textsuperscript{27}, Soyabean\textsuperscript{37}, Groundnut\textsuperscript{45}, \textit{Withania somnifera}\textsuperscript{5}. 

Corindrum sativum Linn⁴³, Phaseolus vulgaris Linn⁸, Lathyrus sativus, Linn⁵⁹. Effect of SA as chemical mutagens on the yield parameters of the cultivars in M₂ and M₃ generation in Chickpea were reported²⁶. The similar results was reported in Horse gram⁷ and Mungbean⁵⁰. In the present investigation the M₂, M₃ and M₄ generation succeeded in inducing the genetic variability and improve the chances of further effective selection.

Summary:

The data of quantitative characters of the five characters like plant height, number of pods per plant, length of the pod, number of seeds per pod and 100 seeds weight was observed and collected in M₂, M₃, and M₄ generations. The statistical analysis of the data was computed to understand the effect of the mutagens in shifting the mean and variance in either direction. The mean, variance and the coefficient of variance were computed. The positive shift of mean in all the quantitative characters was observed in all the parameters. The quantitative character was controlled by the polygene and exhibit continuous distribution. The expression of the quantitative characters were also under the environmental influence therefore the role of induced mutation in crop improvement was based on quantitatively inherited characters which was subjected to the statistical analysis.

The main objective of the plant mutation breeding and induced mutagenesis was to increase the variability of the genetic material of the plant. Which develop the desirable genotype of the plant carrying the beneficial characters of high economic values. Mutagenesis can enhance the natural mutational rate and enlarges the variability of the plant and desired selection of the germplasm.

CONCLUSION:

In the present investigation of the physical and chemical mutagens were succeeded in inducing the superior genotype by altering the genetic material in growth and metabolism of the plant. The mutagens like EMS and Gamma rays have successfully induced genetic variability in different mutants. The mutants like Dark green leaves, Spreading and Luxuriant was observed highest yield in contributing parameters and even more protein and carbohydrate content as compared to control. These mutants could be promoted for cultivation after successful completion of seed certification process.
REFERENCES


