Mutations are sudden heritable changes in the genotype of an organism not explainable by recombination of pre-existing genetic variability. The concept of mutation (a term coined by De Vries, 1901) is pervasive in genetics. It is considered as an alternative source to naturally occurring variability for plant improvement programmes and as an alternative to hybridization and recombinations in plant breeding.

Mutation is the ultimate source of all genetic changes (variations) and provides the raw material for evolution. Such genotypic changes include: changes in chromosome number (euploidy and aneuploidy), gross changes in the structure of chromosome (chromosome aberrations) and changes in individual genes (point mutation). It is a process by which the genetic information is changed in a stable manner, either in nature or experimentally by the use of chemicals or radiations. Induced mutations are found to be successful in shortening the life cycle, improving yield characters as well as grain qualities etc.

The agents which possess the quality of acting upon the genetic material and cause mutations are called as mutagens. Mutagens are of two types:

(i) Physical mutagens such as non-ionizing (UV-rays) and ionizing radiations (X-rays, γ-rays etc.).

(ii) Chemical mutagens such as alkylating agents (EMS, MMS, DMS and DES etc.), base analogues (5-bromouracil etc.), acridine dyes (proflavin, acridine orange compounds etc.) and other direct acting chemicals.
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(nitrous acid, mustard gas etc.).

During the late 1920s, geneticists got new opportunities for creating variabilities in organisms after the discoveries that genetic material is amenable to change (Chopra, 2005). Mutagenic action of X-rays was discovered by Muller (1927) in Drosophila and Stadler (1929) in barley and maize. Muller demonstrated that X-rays treatment markedly increased the frequency of sex linked recessive lethal mutations in Drosophila melanogaster.

Physical mutagens predominantly induce chromosome aberrations either through ionization of the target itself or indirectly through mutagenic free radicals as a result of ionization of background components. Chemical mutagens have shown evidence of more specific action than the physical mutagens, which act at random. Many cases of mutagenic specificity have been found to be regional (with reference to the chromosome) rather than genic. Though, there were several attempts to induce mutations by chemical agents (Westergard, 1957; Gustafsson, 1969), the first definite evidence that chemical agents can induce mutations was given by Auerbach and Robson (1942) in Drosophila by using mustard gas and Oehlkers (1943) in Oenothera by urethane.

It was clear from the pioneering studies in Sweden that alkylating agents are particularly suited for mutagenic studies in plants (Ehrenberg & Gustafsson, 1957; Ehrenberg, 1960). In Europe, Japan and China emerged as great centers for induced mutagenesis work in 1950s on this planet (Chopra, 2005) and at the same time Swaminathan and his co-workers also initiated studies on chemical mutagenesis in crop plants at the Botany Division, Indian Agriculture Research Institute (IARI), India (Natarajan, 2005).

Mutation breeding seems to be a handy tool for improving the
quantitative and qualitative characters in various crop plants. Therefore, physical and chemical mutagens are being used in genetic improvement programmes of different plant species including triticale (Viswanathan & Reddy, 1998), *Lens culinaris* (Reddy & Annadurai, 1992; Verma et al., 1999), *Vigna radiata* (Khan, 1999), *Triticum aestivum* (Kalia et al., 2000), *Vicia faba* (Khan et al., 2005a, b; 2006a, b), *Trigonella foenum-graecum* (Jabee et al., 2007) and *Helianthus annuus* (Khursheed et al., 2009).

The present material *Solanum melongena* L., selected for mutagenesis, commonly known as eggplant, aubergine, melongene, guinea squash, madapple, bitter tomato, garden egg, baingan or brinjal etc., belongs to family Solanaceae. It is a common vegetable in India, China, Egypt, Turkey, Florida, France and Italy.

### I. EGGPLANT: A BOTANICAL DESCRIPTION

**Habit:** Eggplant is erect, semi erect or prostrate, branched, perennial herb or sub-shrub with strong bushy appearance, reaching a height of about 1 meter on maturity, perennial in habit but may be cultivated as annual.

**Root:** Plant produces a strong tap root which penetrates quite deep into the soil.

**Leaves:** Large in size, alternate, exstipulate, simple, petiolate, ovate with slight lobed margins.

**Inflorescence:** Extra-axillary cyme, flowers are solitary to cluster.

**Flowers:** Ebracteate, pedicillate, cyclic, bisexual, actinomorphic, pentamerous.

**Calyx:** Gamosepalous, free lobed, persistent and densely covered with hairs.

**Corolla:** Five lobed, gamosepalous, bell shaped, purple, violet to pinkish white in colour.
Androecium: Five, epipetalous stamens, alternating with petals; anthers long, erect, basifixed and connivent, often tapering upwards and dehiscing by apical pores.

Gynoecium: Bicarpellary, syncarpous, superior ovary. Ovary bi-tetralocular, each locule containing large no of ovules on swollen axile placenta.

Fruit: Large, berry, varying in shape, spherical to cylindrical, smooth and glossy surface.

Seeds: Small, flattened, kidney shaped, pitted and endospermic with covered embryo.

The present systematic position of brinjal

Kingdom : Plantae - Plants
Subkingdom : Tracheobionta - Vascular Plants
Super division : Spermatophyta - Seed Plants
Division : Magnoliophyta - Flowering Plants
Class : Magnoliopsida - Dicotyledons
Subclass : Asteridae
Order : Solanales
Family : Solanaceae - Potato Family
Genus : Solanum - Nightshade
Species : Solanum melongena - Eggplant, Brinjal

II. CULTIVATION:

Eggplant (Brinjal) requires a long warm growing season for its proper growth (Choudhury, 1990). The damage to the eggplant flowers due to high temperature results in decreased pollination rates, reduced fruiting, and increased fruit abscission (Sun et al., 1990; Nkansah, 2001). Eggplants suffer rapid physiological disorders manifested mainly by the appearance of surface
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injuries such as pitting, scald, seed darkening and flesh browning, especially in the calyx below 12 °C (Fallik et al., 1995). The mean growing temperature of the crop is between 13 °C to 21 °C for its successful production. The crop can be grown thrice during the year as autumn-winter, spring-summer, and rainy season crop and therefore, the fruits which are used as a vegetable are almost available throughout the year.

III. AREA UNDER PRODUCTION AND PRODUCTIVITY OF EGGPLANT:

Most eggplants in Asia are produced by small-scale farmers, and the sale of the fruit is an important source of cash income (Rashid et al., 2003). Development of new varieties through mutation breeding with higher nutrient content could be particularly beneficial to poor consumers. It would be especially important in South Asia, where annual per capita vegetable availability ranges from 10 to 54 kg (FAO, 2005), far below the recommended level of 73 kg (Ali & Tsou, 1997). In 1999, 1.3 million ha were cultivated in the world for a total production of 21.2 t, of which 92.4% of the world productions were covered by Asia (FAO, 1999). Based on production statistics, eggplant is the third most important crop in Solanaceae, after potato and tomato (FAO, 2000). China, India, Bangladesh, Nepal and Sri Lanka account for about 80% of the world’s eggplant production area (FAO, 2005). The greatest eggplant producers are China (18 t), India (8.4 t), Egypt (1 t) and Turkey (0.8 t) (FAO, 2007).

IV. NUTRITIVE VALUE AND MEDICINAL IMPORTANCE:

Vegetables play a pivotal role in our diet as they are the main source of some important supplements, especially vitamins and minerals. Most of the fruits of genus Solanum are used as vegetables and the eggplant is one of the most common and popular vegetables grown throughout India. Nutritive
value of eggplant is also noteworthy (Choudhary & Malda, 1968; Siddiqui, 1989). However, eggplant fruits contain ascorbic acid and phenolics, both of which are powerful antioxidants (Cao et al. 1996; Vinson et al., 1998).

Eggplant is of considerable medicinal value (Nadkarni, 1927; Chopra et al., 1956; Khan 1979; Siddiqui, 1989). In Unani system of medicine the root of eggplant is used to alleviate the pain (Siddiqui, 1989). In addition, several researchers have provided evidence that eggplant extracts have a significant effect in reducing blood and liver cholesterol rates in humans (Khan 1979; Jorge et al., 1998; Kayamori & Igarashi 1994; Jenkins et al., 2003).

The pulps of root and leaf are mixed with natron to treat rheumatic disease and swollen joint pains (Dalziel, 1937). An infusion from the leaves is used against asthma, bronchitis, urinary disorders, and wounds resulting from syphilis (Ambasta, 1986; Jain & De Fillips, 1991). In countries such as Madagascar and South Africa, the leaves, fruits, and seeds are said to be in use in diverse ways and even curing diseases like syphilis. Unripe fruits are used as a laxative, appetizer, cardiotonic (Ambasta, 1986; Jain & De Fillips, 1991).

The eggplant also bears ayurvedic medicinal properties and white brinjal is said to be useful for the diabetic patients (Choudhury, 1990). The food recipes of the National Diabetes Education Program of National Institute of Health (NIH) and American Diabetes Association (ADA) and Mayo Clinic recommended eggplant as a part of the diet for management of type 2 diabetes (NIH, 2007; ADA, 2007; MAYOCLINIC, 2007).

In view of the above mentioned importance the present investigation has been carried out which deals with the study of mutagenic effect of γ-rays (Physical mutagen), methyl methane sulphonate (MMS), dimethyl sulphate
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(DMS) and diethyl sulphate (DES) (chemical mutagens), on the basis of their differential efficiency and effectiveness in inducing genic or chromosomal mutations. The assessment of mutagenic effects of these physical and chemical mutagens has been done on various parameters, including seed germination, seedling and plant growth, survival rate, variation/mutation frequency, branching, fruiting, fruit weight, fruit size, 1000-seeds weight and yield. Cytogenetic studies in control and mutagen-treated populations have been done in detail and possible genetic reasons have been worked out for morphological variations.

V. OBJECTIVES:

The investigations reported in the thesis have been carried out in M1, M2 and M3 generations, keeping the following objectives in view.

➢ To study the effect of different mutagenic treatments on various biological parameters such as seed germination, plant survival, pollen fertility, growth, morphology, yield etc. in M1, M2 and M3 generations,
➢ To investigate the meiotic behaviour of chromosomes after treatments with physical and chemical mutagens in M1, M2 and M3 generations,
➢ To find out the effectiveness and efficiency of gamma rays, and other alkylating agents (MMS, DMS and DES) in inducing mutations in M2 generation,
➢ To induce maximum variations, with minimum damage of the plants, for the selection of mutants in M2 and M3 generations.
➢ To select and maintain the mutants in M3 generation on the basis of morphological characters.