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1.1. General account

India grows a variety of pulse crops, also called as grain legumes, under a wide range of agro-climatic conditions and has a pride of being the world’s largest producer of pulses. Unique characteristics like high protein content (2 to 3 times more than the cereals), nitrogen fixing ability, soil ameliorative properties and ability to thrive better under harsh conditions make pulses an integral component of sustainable agriculture particularly in dry land areas. Indian population relies on pulses for meeting its protein requirement mainly because of its vegetarian food habit and high cost of animal based protein. The country has witnessed a decreasing trend in the per capita availability of pulses from 69 g in 1961 to 37 g in 2005. A solution to the problem of declining per capita availability has, therefore, to come from a rapid improvement in indigenous production levels. While efforts have been geared up to bring additional area under pulses, more important is to increase the production by exploiting yield potential of the existing varieties through genetic manipulation. The estimates for 2006 indicate that the pulses occupy an area of 22.43 million hectares and produce 13.11 million tonnes with an average yield of 585 kg/ha (Fig. 2). During the last decade (1995-2005), the average growth rate of pulses production was 1.27 percent which is far below the required growth rate to meet the domestic requirement (Ali and Kumar, 2006). The non-availability of high yielding varieties is a major constraint in achieving higher productivity of
pulses. Non synchronous maturity, long duration and flower drop are other problems associated with the varieties of major pulses.

Mungbean or green gram (*Vigna radiata* (L.) Wilczek) which ranks third to chickpea and pigeonpea, is an important pulse crop in Southeast Asia and the Indian sub-continent. Mungbean is grown in almost all the states of India and is cultivated as a kharif (monsoon) and summer season crop in different agro-ecological regions. Loam to sandy loam soils with good internal drainage are considered ideal for mungbean cultivation. In India, mungbean was grown over an area of 3.35 million hectares with the production of 1.03 million tonnes in 2006 (Fig. 1). The average yield of 315 kg/ha is low and is not sufficient to meet the growing demand. In order to break the yield plateau in mungbean, efforts are needed to develop high yielding varieties with appropriate growth habit. The breeding methodology applied to mungbean has been purely conventional (selection and hybridization). In some cases, the progress obtained for productivity has exploited the variability to such a large extent that only further progress from the classical methods of breeding becomes more and more difficult. The possibility offered by mutagenic agents to induce new genetic variation is, therefore, of extreme interest. Since mungbean is a self-pollinated crop, mutation breeding could be rewarding for broadening the genetic base of important traits such as yield attributes.

1.2. **Economic importance**

Seeds of mungbean are highly nutritious containing 24% protein, 1.0 – 1.5% fat, 3.5 – 4.5% fibre, 4.5 – 5.5% ash and 59 – 65% carbohydrate on dry weight basis (Tsou *et al.*, 1979) and provide 334 – 344 k cal energy (Srivastava and Ali, 2004). The mineral component is high in phosphorous
Fig. 1. National trends in area, production and yield of mungbean.

Fig. 2. National trends in area, production and yield of pulses.

Source: Division of Crop Improvement, Indian Institute of Pulses Research (IIPR), Kanpur, India.
(370 mg/100 g), calcium (118 mg/100 g) and iron (8 mg/100 g). Mungbean protein is considered to be easily digestible. Being rich in quality proteins, minerals and vitamins, it is inseparable ingredient in the diets of a vast majority of Indian population.

The dried grains of mungbean can be split or eaten whole after cooking and made into a soup or dhal (porridge). Mungbean is also eaten as sprouts. Green pods and seeds can be cooked as vegetables. It is also recommended as a medicinal diet in case of flatulence and to the sick. It is rich in vitamin B and is regarded as a remedy for beri-beri. Dried and green stalk and leaves of mungbean are used as fodder.

1.3. **Botanical description**

Mungbean belongs to the genus *Vigna* of the family Fabaceae (Papilionaceae). The plant has tap root, provided with nodules. Stem is erect or suberect, furrowed and branched. Leaves are trifoliate, ovate with large petiole. Inflorescence is axillary raceme. Flowers are cleistogamous, bisexual with papilionaceous corolla, 10 stamens [(9) + 1], monocarpellary, unilocular and superior ovary. Pollination takes place before the opening of the flower bud. Mature pods are round and have grey or brownish colour. Seeds are globular, green but sometimes marbled with yellow brown, purple brown or black; hilum is white, round and more or less flat. Germination is epigeal.

1.4. **Induced mutations**

Mungbean is a self-pollinated crop. Due to lack of sufficient natural variability, conventional methods of plant breeding had a limited scope in the improvement of mungbean. Micke (1999) advocated that mutation approach was superior to other methods of crop improvement especially in
cases where the required amount of variation could be produced rapidly. Mutation breeding is a well functioning branch of plant breeding supplementing to conventional methods in a favourable manner (Gottschalk, 1986). Mutation breeding combines several advantages in plant improvement by upgrading a specific character without altering the original genetic make-up of the cultivar. In that sense, it provides a rapid method to improve local crop varieties, without going through extensive hybridization and back crossing used in conventional breeding. One of the chief advantages of mutation breeding is that it can give rise to many different mutant alleles with different degree of trait modification. In contrast, transposon or T-DNA mutagenesis generally leads to loss of function through gene disruption (Chopra, 2005). Therefore, conventional mutagenesis is still favoured for crop improvement.

In recent years a lot of work has been undertaken on induced mutagenesis through physical and chemical mutagens. It has been clearly shown in a number of plant species that the effect induced, varies with the varying mutagens and with the variation in mutagen doses. Thus selecting a mutagen and its optimum dose for a genotype in any plant species is an important step in mutation breeding programme. Records maintained by the joint FAO/IAEA Division in Vienna show that more than 2000 crop cultivars which derived one or more useful traits from induced mutations were released worldwide and have an enormous economic impact upon agricultural production (Maluszynski et al., 1995; FAO/IAEA, 2003). In pulses, a total of 265 varieties have been developed using induced mutations (Bhatia et al., 2001). In mungbean, only 14 such mutant varieties have been released for cultivation which is a poor figure in comparison to other pulses.
Out of 14 mutant varieties developed, 13 have been developed by using gamma rays or X-rays and one after the chemical mutagen treatments. Mutation breeding technique may have a greater role in crops like mungbean where a large part of the natural variability has been eliminated in the process of adaptation to the stress of the environment. Mutations are grouped into two major categories on the basis of their phenotypic manifestations:

(i) micromutations – these involve changes in quantitative traits and can be measured at the level of population using various statistical parameters, such as, character mean, variance, heritability etc. and,

(ii) macromutations – with large changes in the characters which can be detected even without instrumental help at the level of individual plant.

The interest in micromutations for generating polygenic variability increased after Brock (1965) proposed the hypothesis of induction of quantitative variability through mutagenic treatment. Micromutations produce genetic variability in quantitative traits of the crop plants. Hence, they deserve full attention of plant breeders. Such mutations should be useful for improving quantitatively inherited traits (such as yield) without disturbing the major part of the genotype and the phenotypic architecture of the crop. In the recent years, there have been a number of attempts to assess radiation induced genetic variability in quantitative traits of pulses. However, little information exists concerning the influence of chemical mutagens on quantitative traits in mungbean.

1.5. Objectives

Keeping in view the economic and nutritional importance of mungbean – a self-fertilized crop, the present study is aimed at
understanding the genetic basis of quantitative traits in *Vigna radiata* about which information is very scanty. An attempt has been made to evaluate quantitative traits in M₁ to M₃ generations following mutagenesis with ethylmethane sulphonate (EMS), hydrazine hydrate (HZ) and sodium azide (SA) in two varieties of mungbean viz., PDM-11 and NM-1.

The following are the aspects studied during the course of present study:

1. to study the biological damage caused by the mutagens in M₁ generation
2. to study the frequency and spectrum of chlorophyll and morphological mutations in M₂ generation
3. to compare the effectiveness and efficiency of different mutagens
4. to determine the component(s) having the highest contribution to seed yield
5. to determine the extent of genetic variability present in the components and their possible effect on the scope for advancement through selection
6. to enhance the yield potential by isolating promising lines
7. to study the total seed protein content in the isolated mutant lines.