Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 03, Issue: 04 (JULY-AUGUST, 2023)
Available online at http://www.agriarticles.com

Mutation Breeding in Pulses and Its Importance

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Abstract
Mutation breeding is a conventional and potential tool to widen the genetic base of variation and to isolate genotype with desirable traits. It combines several advantages in plant improvement by upgrading a specific character without altering the original genetic make-up of the cultivar. In order to improve yield and other polygenic characters mutation breeding can be effectively utilized. During mutation by any mutagenic agent, a pre-mutation lesion passes through cellular sieves before its realization into the phenotypic change, but the recovery of desirable mutations is very low. Thus, effectiveness of mutation breeding programme depends on the effectiveness and efficacy of mutagenic treatment. The extent of induction of mutation varies with species, mutagen and doses used. Thus, selection of a mutagen and its optimum dose for a genotype is important for maximizing the frequency of induced mutation in any plant species. So, as the primary objectives of mutation breeding is to enlarge the frequency and spectrum of mutations as an approach towards directed mutagenesis.

Introduction
Pulses (grain legumes) are the backbone of agriculture because only pulses are the crops that will open the door of sustainability in the field of agriculture. They are an economic source of not only protein but of carbohydrates, minerals and B-complex vitamins. Pulses by virtue of their high protein content and easy digestibility provide an answer to the persisting problem of malnutrition. Pulses contain 18 to 32% protein and 1 to 5 % fat, which is almost twice the protein in wheat and thrice that of rice (Srivastava and Ali, 2004). Pulses are considerably richer in calcium than most cereals and contain about 100 to 200 mg of calcium per 100 g of grain. They are also rich in iron, thiamine, riboflavin, and niacin as compared to cereals. The energy content of most pulses have been found to be between 300 and 540 Kcal/100 g which come from the nutrient supply of protein, fat and carbohydrate (Ofuya and Akhidue, 2005). Pulses provide significant nutritional and health benefits, and are known to reduce several non-communicable diseases. Hence, pulses are a very important source of food and nutrients for the teeming poorer section of the people and animals in the world. Besides the nutritional value cultivation of pulses insures reduction of fertilizer costs, natural rejuvenation of the soil, low water usage and reduction in CO2 emission and greenhouse gases.

Frequency and Spectrum of Chlorophyll Mutations
The most important aspect in mutation breeding is to decide about the appropriate mutagen to be used and method of treatment to be adopted. This is decided by considering the mutagen effectiveness and its efficiency to induce more number of mutations in M2 generations has been used as a valid criterion for selection of the proper treatment conditions.

The scoring of chlorophyll mutations in M2 generation has been proved to be most dependable index for evaluating the genetic effects of mutagenic. In mutation breeding chlorophyll mutations have great significance for methodological investigation. Frequency of chlorophyll mutations in M2 generation following the treatment are serves as a guideline to determine the effectiveness of mutagenic treatments.

Kartashova *et al*. (1972) studied production of mutations induced by gamma rays treatment in four pea varieties. They found highest chlorophyll mutation frequency and broadest spectrum at the flowering phase. In the first stages of development, the mutants were lethal and no chlorophyll mutants appeared after the flowering period was over.

Mutagenic Effectiveness and Efficiency

The usefulness of mutagen in plant breeding not only depends on its mutagenic effectiveness but also on efficiency. The effectiveness is the rate of mutation in relation to dose ignoring the biological damages. On the contrary, mutagenic efficiency measures the rate of mutation in relation to biological damages like lethality and sterility.

Mohan and Sharma (1991) tested mutagenesis of gamma irradiation, ethyl methane sulphonate (EMS) and N-nitroso-N-ethylurea, by treating seeds of Arkel, Mahndorfer and their hybrid with 3-9 kR gamma radiation, 0.10-0.30% ethyl methane Sulphonate and 0.007-0.021% N-nitroso-N-ethylurea. The effect of the treatments on 5 characters in the M1 was evaluated. Intermediate values were generally observed for the hybrid. The total mutation frequency in M2 was significantly highest in the hybrid regardless of the mutagen used.

Results and Discussion

Induced mutagenesis finds a prominent place in the augmentation and recreation of genetic variability which was lost by too rigid selection or narrow base of germplasm of a crop plant under improvement, the potentiality of mutations for this purpose, however depends upon the efficiency of induction of mutations to be aimed at, efficiency of screening of the mutants and on the nature of induced mutation. Mutagens vary in their mode of action, effectiveness, efficiency and the spectrum of mutations induced. Similarly, genotypes show differential sensitivity towards mutagens even at varietal level.

Biological damage: The estimation of biological damages caused by mutagens help in determining the sensitivity if a biological material as well as the potential of a particular mutagen. It was observed that mutation bring about a reduction in seed germination, seedling height, pollen fertility and survival of the pulse crops.

Seed germination (%): Results on seed germination from the studies indicate that, percent seed germination decreased with increasing concentration of mutagens in all pulses indicating a dose dependent response. Although the degree of reduction in seed germination for different crops varied. It is clearly indicates that mutagens have exerted an inhibitory effect on seed germination. These findings are in close agreement with the earlier reports of Shrivastava *et al.* (2008), The increase in sensitivity depends on the metabolic processes which is increased due to presoaking. This may eventually lead to decrease in the rate of respiration and lack of required enzymes for carrying out normal metabolism (Giri, 2010). The reduction in germination by mutagens might be due to its effect on genetic, physiological and cytological processes

Seedling height (cm): The height of seedlings for pulses decreased with increasing concentration of mutagens showing that seedling injury is positively correlated with concentration. Decrease in seedling height with increased concentration of mutagen has been reported by Srivastava *et al*. (2008), Seedling height is widely used as an index in determining the biological effects of various mutagens in M1 generation (Konzak *et al*., 1965). Various explanations have been provided to explain the phenomenon of reduced seedling growth. According to Giri (2010) the mutagen might inactivate the meristem, inhibit

cell division, reduces number of cells contributing to seedling height and/or results in chromosomal damage leading to slow rate of meristematic action of shoot apex; resulting in reduced seedling height.

Survival percentage (%): The analysis percentage survival during the early growth stages of pulses showed an inverse relationship between concentration of mutagens and survival percentage. Experimental results on effect of mtagens on different pulses indicated that the percentage of survival of mutagen treated M1 plants decreased with increase in the concentrations of the mutagens.

The rapid infusion of chemical mutagen and their ability to produce chromosomal aberration and damage to genetic material is advocated by several workers as one of the causes for reduced survival percentage in M1 generation after mutagen treatment.

Pollen fertility (%): Pollen fertility is also a measurement of sensitivity to mutagenic treatment. The rate of pollen fertility reduced with increase in the concentration of mutagens.

Mutation generally reduces the reproductive capacity of the plants. The causes of reduced pollen fertility may be due to chromosomal aberrations (deficiency, duplication, translocation and inversion etc.), gene mutations and physiological effects (Kharakwal, 1981; Konzak *et al*., 1965). Singh and Chaudhary (1972) indicated various reasons like poor growth, chlorophyll deficiencies and chromosomal abnormalities for enhanced pollen sterility.

Plant growth and crop duration: The characters considered under this subheading are plant height at maturity, days to 50 percent flowering and maturity. There were varietal differences for these characters among the pulses which might be attributed to the genetic background of the cultivars.

Grain yield and its components: The results of number of seeds per pod indicated a clear picture of reduction in the character with increase in the dose. This can be an indirect effect rather than direct where the reduction in the pollen fertility can be attributed as one of the cause for this response. As that in pollen fertility there might be some effect in the ovule fertility as well which might also contribute to this response.

Chlorophyll mutation: Chlorophyll mutations have been used as an index in evaluating the mutagenic action of different mutagens in several crops. It is important in assessing the potency of mutagen and also an indicator of factor mutations.

Chlorophyll mutation frequency: The frequency of chlorophyll mutations is the most reliable measure for assessing the potentialities of mutagen in creating genetic variabilities. Chlorophyll mutations are generally not useful for plant breeding purposes, but it is the indicator of the mutagenic effect. Chlorophyll mutation has been used as mutagenic parameters by many workers. The result for the chlorophyll mutation in the study indicated that their frequency increased with the increase in concentration of mutagens. As the results from many researchers indicates that different genes govern the type of pigment in a plant. High sensitivity of some loci or the site specific action of mutagen may be attributed as the cause of one type of mutation occurring higher than the other. And also the sensitivity of the genes or loci governing pigmentation of the plants increases with increase in the concentration which might be the reason for increase in chlorophyll mutation with increasing concentration of mutagen.

Chlorophyll mutation spectrum: In many experiment chlorina, viridis, xantha and albina type of chlorophyll mutations were recorded. This was also recorded by Dhulgande and Satpute (2010) in pea and Kumar *et al*. (2009) in cowpea.

The increase in the spectrum with increase in the concentration of mutagens was also recorded. Girija and Dhanavel (2009) working with cowpea, also came to similar results.

Mutagenic effectiveness and efficiency: Effectiveness and efficiency are quite important, as far as the plant breeding is concerned. Mutagenic effectiveness is a measure of the frequency of mutation induced by a unit dose of mutagen while mutagenic efficiency represents the

proportion of mutation in relation to the associated undesirable biological effects, such as lethality, injury and sterility induced by mutagen in question (Konzak *et al*., 1965). Giri (2010) opined that the mutagenic efficiency caries lot of theoretical and practical importance.

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