

ABSTRACT

Effect of gamma radiations on *cajanus cajan* assessed under *in vitro* & *in vivo* conditions

Name of the Candidate: Darakshanda Neelam, Department of Biosciences, Jamia Millia Islamia

Name of the Supervisor: Prof. Syed Akhtar Husain, Department of Biotechnology, Jamia Millia Islamia

Name of the Co-Supervisor: Dr. Mahmooduzzafar, Department of Botany, Jamia Hamdard

Name of the Co-Supervisor: Dr. Shahnaz Subhan, Department of Biotechnology, Amity University

Unlike conventional breeding procedures that involve the production of new genetic combinations from already existing parental genes, nuclear technology causes exclusive new gene combinations with high mutation frequency. Gamma rays, in particular, are well known for their effects on plant development by inducing cytological, physiological and morphological changes in cells and tissues. Gamma rays are often used in developing highly productive plant varieties that are agriculturally and economically valuable. Gamma rays induced mutation breeding and *in-vitro* mutagenesis is practised to develop various desired features in plants to increase their genetic variability. Mutagenesis by gamma rays plays a significant role in generating new mutants with superior qualities that produce higher amounts of commercially important metabolites. The type of irradiation (e.g, acute or chronic) the dose rate or the dose applied, considered physiological parameters such as the species or variety or cultivar, developmental stage at the time of irradiation and finally, inter- individual response variations could all be different in studies and even those that are carried upon genotypes of the same species. The present study addresses the key question, if the experimental plant *Cajanus cajan* will withstand the adverse conditions manifested by the elevated levels and recommended doses of gamma radiation under *in-vivo* and *in-vitro* conditions. Effects of variable doses of the gamma rays, experienced by the experimental plant were assessed in terms of growth, development and synergetic interaction between metabolites, physiological, morphological and biochemical analysis of the model plant. Attempt was made to examine, evaluate and demonstrate the findings of the present investigation recorded in the course of time in dose and response relationship and to draw valid conclusions.

Radiation-sensitivity test showed a decrease in germination percentage with increases in gamma radiation doses in both *in vivo* & *in vitro* studies. Variable doses of gamma radiation, affected germination of *C. cajan* adversely especially at absorbed doses 150Gy and 200Gy. It is an important observation because radiation -sensitivity test is a prerequisite step to investigate the most effective

dosage of irradiation to be used. Optimum doses of ionizing radiations have modulatory role in growth and developmental processes. Effective stimulatory dose for plant development under *in vivo* conditions is 100Gy while the absorbed doses of 150Gy and 200Gy can prove detrimental. However under *in vitro* conditions, results hold 150Gy as threshold dose for increasing plant growth, plant vigour and development. In this context, further work is required where the response of plant to different doses of gamma radiation can be elaborated.

Autonomous growth has been shown in tissues transformed by bacteria, viruses, chemicals and genetic factors. In the present study, a significant increase in callus induction was observed with increase in doses of gamma radiation with autonomous growth in callus leading to the formation of callus tumors resembling the shape of crown gall tumors, showing a major shift in metabolic pathways. Regeneration frequency showed a direct co-relation with increase in doses of gamma radiation under *in vitro* conditions. Maximum enhancement was observed with an absorbed dose of 150Gy. Better responses observed for the 150Gy could suggest that the type of chromosomal alterations that took place eventually produced a change in the morphology. A reverse effect was observed in yield attributes under *in vivo* studies. Yield parameters such as number of seeds per pod and dry weight of 100seeds showed a significant enhancement with 100Gy. However, a dose dependent reduction in all the yield parameters was observed with increasing doses of gamma radiation in control as well as treated plants. Lower doses of gamma radiation showed a low percentage of aberration index and revealed more or less normal pairing like that of control. A consistent increase in the frequency of various types of chromosomal abnormalities was observed with increasing doses of gamma radiations.

Biochemical analysis confirmed that protein content, photosynthetic pigments, nitrate content, nitrate reductase activity are very sensitive to gamma radiation and are good indicators of tolerance. The differences between various cultures in their ability to accumulate such compounds were evident under stress but not under controlled conditions. Cultured cells and tissues have been reported to accumulate secondary metabolites in excess compared to grown in natural environment. In our study, *in vitro* grown cultures produced more luteolin than field grown plants. Among various gamma radiation doses, maximum luteolin was found in 12weeks old regenerative callus at 150Gy absorbed dose. Thus it appears from the present observation that some of the cultures of *C. cajan* are tolerant to gamma irradiation and over-produce luteolin. Elicitation of secondary metabolites has applications in over-production of desired compounds of commercial importance especially for high value low volume products.