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Short Communication

Effects of gamma radiation on germination and growth characteristics of spine gourd (*Momordica dioica* Roxb.)

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Spine gourd (*Momordica dioica* Roxb.) is originated in Indo Malaya region and widely distributed in tropical and sub-tropical parts of India and adapted to a wide range of soil and climatic conditions (Basumatary et al. 2014). It is highly nutritious vegetable containing high amount of protein as compared to other cucurbitaceous vegetables with a high medicinal value, mainly cultivated for its fruits. Changing conditions had an urge plant breeder to practice on some avant-garde methods such as genetic engineering and mutation breeding, as an addition to traditional methods. Like in other crops there is a genetic bottle-neck due to traditional breeding studies. Genetic creating a mutation may lead to the possibility of creating a desired feature(s) which does not available in the nature or has been lost during the evolution. With the mutation practices, chromosomes are broken, or genes are changed (Novak and Brunner 1992). The most important point of mutation breeding is to select the suitable mutagen and develop a method to determine the mutants (Ukai Y 2006). Radiation practice, which is a physical mutagen, is widely used method in mutation works. The 90% of obtained mutants were created through this application (64% with gamma rays, 22% with X-rays) (Jain 2005, Jain 2010). High-dose mutagen applications are more effective in mutation practices for providing the possibility to create more mutant individuals. Yet, the highest applicable dose is not used as uncalled mutations that lead for infertility and the loss of plant life might occur (Koornneef 2002). Slow rate growth or seedling damages that seen after seed germination is usually an indicator of that the plant was damaged genetically. Seed germination might be seen in high-dose practices; however, the high dose leads the loss of plant life afterwards (Nouri et al. 2012). The key factor in irradiating the plant material is the dose amount that determines the radiation absorbed by the plant. Determination of suitable mutagen and dosage combination were aimed in previous studies conducted on many vegetables, fruits and field crops (Chopra 2005). As a starting point, it is needed to determine LD50 (Lethal Dosage) value to define exact mutation dose (Predieri 2001). The plants sensitivity to irradiation varies according to species, cultivar and the plant's physiological conditions (Britt 1996). Mutation dose is much more important than mutagen type. No matter what mutagen is used, firstly, appropriate dose of the mutagen should be determined before a large-scale application. Therefore, the aim of this study is to determine the optimum doses for radiation treatment of spine gourd, which is not standardized till date in this important potential vegetable crop.

A release variety Indira Kankoda-1 was used in this study. The seeds were treated with acute gamma radiation at the doses of 0, 50, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325 and 350 grays at the Bhabha Atomic Research Center, Mumbai, India. The M_1 seeds were used in this study. Germination test was carried out in a greenhouse at the Research cum instructional farm, RMD college of Agriculture and research Station, Ambikapur in 2018.

The survival percentage at 20 days after germination was then calculated as follows:

$$\text{Survival (\%)} = \left[\frac{\text{No. of survival plants at 20 days after germinatio n}}{\text{Number of seeds}}\right] \times 100$$

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The survival percentage at 30 days after germination was then calculated as follows:

$$\text{Survival (\%)} = \left[\frac{\text{No. of survival plants at 30 days after germination}}{\text{Number of seeds}}\right] \times 100$$

The survival as percent of control at 20 days after germination ($GR50_{(20)}$) was then calculated as follows:

$$GR50_{(20)} = \left[\frac{\text{No. of survival plants at 20 days after germination}}{\text{Number of germinated plants}}\right] \times 100$$

The survival as percent of control at 30 days after germination ($LD50_{(30)}$) was then calculated as follows:

$$LD50_{(30)} = \left[\frac{\text{No. of survival plants at 30 days after germination}}{\text{Number of germinated plants}}\right] \times 100$$

The experiment was designed according to completely randomized with three replications and data analysis was carried out using the PBTools, version 1.4. 2014. Biometrics and Breeding Informatics, PBGB Division, International Rice Research Institute, Los Baños, Laguna.

Analysis of variance showed significance differences ($p \geq 0.01$) among gamma ray treatments for germination percentage at 20 days after germination (DAG), survival percentage at 30 DAG, plant height and number of leaves (Table 1). The differences among gamma ray treatments were observed for germination percentage, Survival percentage at 20 DAG, survival percentage at 30 DAG, plant height and number of leaves per plant (Table 2). In this study, the highest germination percent was obtained in control group activities. As seen in Figure 1, with the increase of irradiation dose, germination rates decreased. Reduction of germination rates were observed as from 100% to 15% (275 Gy). The overall means of the experiment across radiation treatments were 51.83% for germination, 49.07% for survival, 6.93 cm for plant height and 3.63 for number of leaves per plant (Table 2). The range for different growth parameters were 15 to 100%, 18.32 to 100%, 2.59 to 14.13cm and 1.40 to 7.56 respectively, for germination percentage, survival, plant height and number of leaves

Table 1: Mean squares for germination and growth parameters in spine gourd subjected to ten levels of gamma radiation.

Source of Variation	df	Germination (%)	Survival (%)		Plant Height	Number of Leaves
			20 DAG	30 DAG		
Replication	2	13.80	4.23	4.23	0.0278	0.13
Treatment	9	2024.90**	2821.95**	2821.95**	56.35**	16.81**
Error	18	5.94	6.98	6.98	0.43	0.37

** Significant at 0.01 probability level, df: Degree of freedom, DAG-Days after germination

Table 2: Effect of gamma radiation on germination and different growth parameters of spine gourd.

Gamma dose	Germination	Survival percentage		Plant Height (cm)	Number of Leaves
		20 DAG	30 DAG		
0 Gy	100.00^{a}	100.00^{a}	100.00^{a}	14.13^{a}	7.56^{a}
50 Gy	75.00^{b}	93.77^{a}	93.77^{a}	13.25^{a}	7.32^{ab}
100 Gy	66.67^{c}	70.38^{b}	70.38^{b}	9.94^{b}	5.63^{b}
125 Gy	61.67^{cd}	61.09^{c}	61.09^{c}	8.63^{b}	3.43^{c}
150 Gy	56.67^{de}	43.57^{d}	43.57^{d}	6.16^{c}	3.21^{cd}
175 Gy	50.00^{ef}	35.95^{d}	35.95^{d}	5.08^{cd}	2.45^{cde}
200 Gy	43.33^{f}	26.03^{e}	26.03^{e}	3.68^{de}	2.34^{cde}
225 Gy	26.67^{g}	21.20^{e}	21.20^{e}	3.00^{e}	1.56^{de}
250 Gy	23.33^{g}	20.44^{e}	20.44^{e}	2.89^{e}	1.43^{de}
275 Gy	15.00^{h}	18.32^{e}	18.32^{e}	2.59^{e}	1.40^{e}
Mean	51.83	49.07	49.07	6.93	3.63
CV (%)	4.70	5.39	5.39	9.52	16.78

per plant. The seeds receiving 0 Gy and 50Gy of gamma radiation were not statistically different for all parameters (Table 2). The reductions in germination, survival percentage at 20 DAG, survival percentage at 30 DAG, plant height and number of leaves were observed at 100Gy but not at 50Gy.

The germination of the control seeds was lower than 100% and then data were converted to 100%. Germination of other gamma radiation treatments were calculated accordingly (Fig 2). The data for germination

Fig 1: Seedlings at germination of spine gourd subjected to different levels of gamma radiation

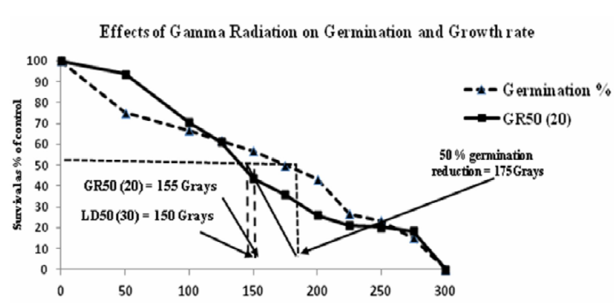

Fig 2: Germination (%), survival (%) of control at 20 days after germination and survival as percent of control at 30 days after germination of spine gourd genotype (Indira Kankoda-1) subjected to different levels of gamma radiation.

percentage, survival as percentage of control at 20DAG ($GR50_{(20)}$) and 30 DAG ($LD50_{(30)}$) were plotted against gamma radiation doses to determine lethal dose (LD_{50}) of radiation. LD50 for germination percentage could be 175Gy, the germinated seeds did not survive, and germination percentage alone was not a good prediction for LD50. The $GR50_{(20)}$ and $LD50_{(30)}$ are good predictions for LD50 and the LD50 for these criteria was at 155 and 150Gy, respectively (Fig 2). Figure 1 showed growth patterns of the seeds treated with different levels of gamma radiation. Gamma radiation greatly reduced plant height and the effect was highest at 150Gy. Gamma rays are the most widely used physical mutagen due to its handling and availability (Joshua D C 2000). Gamma radiation has reported to have beneficial effects on many crops. In Kediny bean (*Phseolus vulgaris* L.), however, the LD50 for germination could not be determined from the doses 300Gy to 800Gy because the radiation had small effect on germination and some treatment had higher germination than control (Ellafa et al. 2007). In wheat, gamma radiation improved germination, plant height, grain per plant, grain yield at 200Gy (Jamil and khan 2002). Gamma radiation at higher doses resulted in the reduction in germination (100-275 Gy) to complete fatality (300 to 350 Gy) of spine gourd seeds. Songsri et al. (2011) found that seeds treated with 200Gy of gamma rays revealed stimulatory effect, whereas 600Gy dose showed inhibitory effects on traits compared to other treatment. This could be due to the damage in seed tissues and the severity of the damage depending on the dosage used (Datta 2009). Gamma radiation had inhibitory effects on physiological and physical traits (Khan and Goyal 2009).

In this study, the rates of gamma ray for mutation in spine gourd were in the range of 150 to 155 Gy according to GR50 dose at 20DAG and LD50 dose at 30 DAG, respectively. However, seedlings of M_1 generation were used for carried out the observations and further the stability of different traits (inter node length, dioecious plant type, fruit length, earliness, fruiting behavior) and variation arises due to irradiation needs more advanced generations. Advance molecular biology tools like molecular markers will help to ensure differences among irradiated lines to control one. As spine gourd is a pharmaceutical crop so the chances for different biochemical products will also analyze in future. It is concluded that the higher dosages of gamma radiation reduced germination of spine gourd seeds, number of survival plant and plant height. In the seed of spine gourd, the dosages that are suitable to induce mutation are in the range of 150-155 Gy according to medial lethal dose at 20 and 30 days after germination. The information provides basic requirements for the use of gamma radiation for mutation induction in spine gourd.

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References

Novak FJ and Brunner H (1992) Plant Breeding: Induced Mutation Technology for Crop Improvement. IAEA Bull 4: 25-32.

Datta SK (2009) A Report on 36 years of practical work on crop improvement through induced mutagenesis. In: induced plant mutations in the genomics Era, Shu, Q.Y. (Ed.). Food and Agriculture Organization of the United Nations, Rome, pp 253-256.

Ellafa K, Ahmed OH, Shaharudin S and Rahman DA (2007) Gamma radio sensitivity study on snap bean (*Phaseolus vulgaris*). Int J Agric Res 2: 844-848.

Jamil M and Khan UQ (2002) Study of genetic variation in yield components of wheat cultivar bukhtwar-92 as induced by ã radiation. Asian J of Pl sci 1:579-580.

Khan MR, Qureshi AS, Hussauin SA and Ibrahim M (2005) Genetic variability induced by ã irradiation and its modulation with gibberelic acid in M2 generation of chickpea (*Cicer arietinum* L.). Pak J Bot 37:285-292.

Songsri P, Suriharm B, Sanitchon S, Srisawangwong S and Kesmala T (2011) Effects of gamma radiation on germination and growth of physic nut (*Jatropha curcas* L.). J of Bio Sci 11 (3): 268-274.

Jain SM (2005) Major mutation-assisted plant breeding programs supported by FAO/IAEA, Plant Cell, Tissue and Organ Culture 82: 113–123.

Jain SM (2010) Mutagenesis in Crop Improvement under the Climate Change. Romanian Biotechnological Letters 15(2): 88-106.

Ukai Y (2006) Effectiveness and Efficiency of Mutagenic Treatments, Gamma Field Symposia Number 45: 1-15, Japan.

Koornneef M (2002) Molecular Plant Biology. Gene Identification: Classical Mutagenesis in Higher Plants, pp 1-13.

Britt AB (1996) DNA Damage and Repair in Plants. Annual Reviews Plant Physiology 47: 75-100.

Chopra VL (2005) Mutagenesis: Investigating the Process and Processing the Outcome for Crop Improvement. Current Sci 89(2): 353-359.

Nouri H, Kiani D and Khani MAH (2012) Investigation of Mutagenic Effects of Various Doses of Gamma Ray on Seed Germination Traits of Pinto Bean Cultivar of Khomein. Annals of Bio Res 3(10): 4977-4979.

Predieri S (2001) Mutation Induction and Tissue Culture in Improving Fruits. Plant Cell, Tissue and Organ Culture, 78: 185–210.