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).

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:

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

\[
\text{GR50}_{20} = \left( \frac{\text{No. of survival plants at 20 days after germination}}{\text{Number of germinated plants}} \right) \times 100
\]

The survival as percent of control at 30 days after germination (LD50\(_{30}\)) was then calculated as follows:

\[
\text{LD50}_{30} = \left( \frac{\text{No. of survival plants at 30 days after germination}}{\text{Number of germinated plants}} \right) \times 100
\]

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<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 per plant. The seeds receiving 0 Gy and 50 Gy 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 100 Gy but not at 50 Gy.

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

![Figure 1: Seedlings at germination of spine gourd subjected to different levels of gamma radiation](image)

![Figure 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](image)

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

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>Germination (%)</th>
<th>Survival (%)</th>
<th>Plant Height (cm)</th>
<th>Number of Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replication</td>
<td>2</td>
<td>13.80</td>
<td>4.23</td>
<td>14.13</td>
<td>5.94</td>
</tr>
<tr>
<td>Treatment</td>
<td>9</td>
<td>2024.90**</td>
<td>2821.95**</td>
<td>2821.95**</td>
<td>56.35**</td>
</tr>
<tr>
<td>Error</td>
<td>18</td>
<td>5.94</td>
<td>6.98</td>
<td>6.98</td>
<td>0.43</td>
</tr>
</tbody>
</table>

** 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.

<table>
<thead>
<tr>
<th>Gamma dose</th>
<th>Germination (%)</th>
<th>Survival percentage (%)</th>
<th>Plant Height (cm)</th>
<th>Number of Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Gy</td>
<td>100.00^a</td>
<td>100.00^a</td>
<td>14.13^a</td>
<td>7.56^a</td>
</tr>
<tr>
<td>50 Gy</td>
<td>75.00^a</td>
<td>93.77^a</td>
<td>13.25^b</td>
<td>7.32^b</td>
</tr>
<tr>
<td>100 Gy</td>
<td>66.67^a</td>
<td>70.38^a</td>
<td>9.94^b</td>
<td>5.63^b</td>
</tr>
<tr>
<td>125 Gy</td>
<td>61.67^a</td>
<td>61.09^a</td>
<td>6.63^b</td>
<td>3.43^c</td>
</tr>
<tr>
<td>150 Gy</td>
<td>56.67^a</td>
<td>43.57^c</td>
<td>6.16^c</td>
<td>3.21^d</td>
</tr>
<tr>
<td>175 Gy</td>
<td>50.00^d</td>
<td>35.95^e</td>
<td>5.08^d</td>
<td>2.45^f</td>
</tr>
<tr>
<td>200 Gy</td>
<td>43.33^e</td>
<td>26.03^f</td>
<td>3.68^e</td>
<td>2.34^g</td>
</tr>
<tr>
<td>225 Gy</td>
<td>26.67^g</td>
<td>21.20^h</td>
<td>3.00^h</td>
<td>1.56^i</td>
</tr>
<tr>
<td>250 Gy</td>
<td>23.33^h</td>
<td>20.44^i</td>
<td>2.89^i</td>
<td>1.43^j</td>
</tr>
<tr>
<td>275 Gy</td>
<td>15.00^i</td>
<td>18.32^j</td>
<td>2.59^j</td>
<td>1.40^k</td>
</tr>
<tr>
<td>Mean</td>
<td>51.83</td>
<td>49.07</td>
<td>6.93</td>
<td>3.63</td>
</tr>
<tr>
<td>CV (%)</td>
<td>4.70</td>
<td>5.39</td>
<td>9.52</td>
<td>16.78</td>
</tr>
</tbody>
</table>

** Significant at 0.01 probability level, df: Degree of freedom, DAG: Days after 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), and 30 DAG (LD50) were plotted against gamma radiation doses to determine lethal dose (LD50) 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 and LD50 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 (Phaseolus 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 M1 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


