OBSERVATIONS
Germination:

The seed germination was studied under field conditions by sowing 100 seeds per micro-plot at equal distance and depth. The emergence of cotyledons to the soil surface was taken as the criterion for germination. Observations were recorded at 24 hours interval.

It was found that the seeds showed germination after five days of sowing in control as well as in 25 Krad treatment, whereas in the rest of the treated lots, seeds germinated on the sixth day. The maximum percentage of germination was recorded on the tenth day in case of control, on the 12th, 13th, 15th, 16th, 17th and 18th day after sowing in 25, 50, 75, 100, 125 and 150 krad treatments respectively, (Figure 1). The total amount of germination obtained under different treatments showed that there is a gradual fall in percentage of germination with the increasing dose of the treatment. The number of seeds germinated under the different treatments ranged from 81 to 98 per 100 seeds, the minimum being in the 150 krad treatment and the maximum in the untreated control (Figure 1).

In M₂ generation the initial germination was recorded in case of control, 25, 50, 75 and 100 krad on 5th day after sowing, while in the rest two treatments germination started on the 6th
Fig. 1

M1 generation

Germination percentage vs. days after sowing for different radiation treatments:
- CONTROL
- 25 KRAD
- 50 KRAD
- 75 KRAD
- 100 KRAD
- 125 KRAD
- 150 KRAD

DAYS AFTER SOWING
**FIG. 2**

M₂ GENERATION

- **CONTROL**
- 25 KRAD
- 50 KRAD
- 75 KRAD
- 100 KRAD
- 125 KRAD
- 150 KRAD

**DAYS AFTER SOWING**

**GERMINATION PERCENTAGE**

- 100
- 90
- 80
- 70
- 60
- 50
- 40
- 30
- 20
- 10
- 10

5 6 7 8 9 10 11 12 13
FIG. 3

M3 GENERATION

GERMINATION PERCENTAGE

DAYS AFTER SOWING

CONTROL
25 KRAD
50 KRAD
75 KRAD
100 KRAD
125 KRAD
150 KRAD
day. The maximum percentage was obtained on the 10th day in control as well as in 25 krad treatment and on the 11th day in 50, 75 and 100 krad treatments. The maximum germination in $M_2$ generation did not follow any trend as it did in $M_1$ generation. The lowest percentage was recorded in 100 krad treatment in $M_2$ generation, while the maximum of 98% in control. Unlike in $M_1$ generation, the range of maximum in $M_2$ generation under the different treatments happened to be quite narrow (Figure 2).

A similar study on germination in $M_3$ generation has shown that the initial germination under all treatments occurred on the 5th day as in control, while the maximum on 10th and 11th day after sowing (Figure 3). The amount of germination in $M_3$ generation ranged from 93 to 96% in the different treatments indicating that the treated seeds had recovered almost to the level of control (Figure 3).

Figure 4 shows the effect of gamma-ray treatments on germination of the variety under investigation. It illustrates the timings of initiation and cessation of the process in the different generations. Figure 5 shows the comparative attainment of the treated as well as the untreated control seeds, in the consecutive generations. It becomes clear from the Figure 5 that total percentage obtained under the different treatments did not vary to any considerable extent. But there has been a
DAYS AFTER SOWING

DURATION OF GERMINATION

FIG. 4
FIG. 5

DOSES IN KRAD

GERMINATION PERCENTAGE

M₁ GENERATION
M₂ GENERATION
M₃ GENERATION
considerable delay in attaining the maximum percentage under different treatments in \(M_1\) generation. Figure 4 illustrates the recovery in this regard in the subsequent generations.

**Survival:**

To study the survival rate of the treated progenies, separate sets of micro-plots each having 100 seedlings were maintained. The survival rate was calculated at the time of harvest. It has been found that the survival percentage happens to be 100% in control and 25 krad treatment. In 50 krad treatment, the survival percentage was 98.9%. Under the rest of the treatments, there has been a considerable fall in the survival percentage following a direct proportion to the intensity of doses, leading to the minimum of 18.5% under 150 krad treatment.

Figure 6 shows the seedling survival of \(M_1\), \(M_2\) and \(M_3\) generations. It indicates that there has been a remarkable recovery in the subsequent generations from the lethal effect of irradiation.
M₁ GENERATION
M₂ GENERATION
M₃ GENERATION

FIG. 6
Growth:

The growth performance of the treated progenies was studied under field conditions at weekly or fortnightly intervals using cotyledonary expansion, root-shoot elongation, branch formation, leaf production and biomass accumulation as parameters. The results obtained are described under separate heads in the following pages for convenience.

Cotyledon:

$M_1$ generation: The cotyledonary leaves of all the treated and the untreated progenies were collected on the 30th day after sowing at the rate of 50 per treatment. The leaf area was measured with the help of a planimeter. It has been found that the average area of cotyledons significantly differs under all treatments compared to that of control, except the 50 krad treatment (Table-1). The mean cotyledonary area, developed under 50, 75 and 100 krad treatments, showed a marginal increase over that of control to an extent of 1.094 to 9.354%. In the rest of the treatments, cotyledonary area showed a significant decrease ranging from 8.759 to 11.366 per cent compared to that of control (Table-1).

The analysis of variance, has demonstrated that the CV value to be higher in 25 and 50 krad treatments and lower in the rest compared to that of control (Table-1).
Table 1: Cotyledonal area of M₁ generation of *L. usitatissimum* L. var. Mukta after 30 days of sowing under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Area of cotyledon in cm²</th>
<th>PV</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1.096 ± 0.2684</td>
<td>-</td>
<td>24.49</td>
</tr>
<tr>
<td>25</td>
<td>1.000* ± 0.2677</td>
<td>-8.75</td>
<td>26.77</td>
</tr>
<tr>
<td>50</td>
<td>1.108 ± 0.3252</td>
<td>+1.09</td>
<td>29.35</td>
</tr>
<tr>
<td>75</td>
<td>1.204* ± 0.2637</td>
<td>+9.85</td>
<td>21.90</td>
</tr>
<tr>
<td>100</td>
<td>1.152* ± 0.2275</td>
<td>+5.10</td>
<td>19.75</td>
</tr>
<tr>
<td>125</td>
<td>0.907* ± 0.1639</td>
<td>-17.20</td>
<td>18.06</td>
</tr>
<tr>
<td>150</td>
<td>0.971* ± 0.1847</td>
<td>-11.36</td>
<td>19.01</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.054</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Significant at 5% level.
± = Standard deviation
PV = Percent variation
CV = Coefficient of variation
L.S.D. = Least significant difference.
In order to analyse the water and dry matter content of cotyledonary leaves, 50 cotyledons were collected per treatment and weighed before and after oven-drying. It has been found that fresh weight of cotyledons showed a significant increase in the progenies of high intensity doses over that of control, while the two lower doses showed a marginal insignificant decrease ranging from 4.380 to 7.885 per cent compared to that of control (Table-2). The analysis of coefficient of variation has shown a higher value in the treated materials than in control with the exception of 25 krad treatment.

The dry weight analysis of cotyledons has shown that the treated progenies differ to a significant level compared to control. Progenies of 25 and 50 krad treatments showed a decrease, while those of the other treatments recorded a significant increase over that of control (Table-2). The analysis of variance of the different populations has shown that the treated ones have a higher value of CV than that of control.

The fresh weight of cotyledons per unit area (cm²) when calculated and compared, it was found that all the treated materials recorded a higher fresh weight per cm² area of cotyledons, excepting the 50 krad treatment, in which the plants showed a decrease to an extent of 5.427 per cent (Table-3). A similar analysis of dry weight content per cm² area of cotyledonary leaves, has shown that the higher doses like 75 krad and
Table -2  Fresh and dry weight (g) of 50 cotyledons of 30 day old stage of M₁ generation of L. usitatissimum L. var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Fresh Weight</th>
<th>Dry Weight</th>
<th>PV</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.625 ±0.1581</td>
<td>0.280 ±0.0158</td>
<td>-</td>
<td>6.02</td>
</tr>
<tr>
<td>25</td>
<td>2.418 ±0.1581</td>
<td>0.217* ±0.0202</td>
<td>-7.88</td>
<td>6.53</td>
</tr>
<tr>
<td>50</td>
<td>2.510 ±0.3162</td>
<td>0.226* ±0.0303</td>
<td>-4.38</td>
<td>12.59</td>
</tr>
<tr>
<td>75</td>
<td>3.275* ±0.2404</td>
<td>0.324* ±0.0483</td>
<td>+24.76</td>
<td>7.34</td>
</tr>
<tr>
<td>100</td>
<td>3.011* ±0.3909</td>
<td>0.320* ±0.0514</td>
<td>+14.70</td>
<td>12.98</td>
</tr>
<tr>
<td>125</td>
<td>2.919* ±0.5603</td>
<td>0.325* ±0.0626</td>
<td>+11.20</td>
<td>19.19</td>
</tr>
<tr>
<td>150</td>
<td>3.047* ±0.4734</td>
<td>0.425* ±0.0728</td>
<td>+16.09</td>
<td>15.53</td>
</tr>
</tbody>
</table>

L.S.D. at 5% level = 0.2743  0.0396

* = Significant at 5% level,  ± = Standard deviation,
PV = Percent variation,  CV = Coefficient of variation,
L.S.D. = Least significant difference.
Table - 3  
Fresh weight, dry weight and water content per unit area of 30 day old cotyledons of \( M_1 \) generation of \( L. \) usitatissimum \( L. \) var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weight in g per cm(^2)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fresh</td>
<td>Dry</td>
<td>Water content</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>M 0.0479</td>
<td>0.0051</td>
<td>0.0427</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>M 0.0483</td>
<td>0.0043</td>
<td>0.0440</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV +0.96</td>
<td>-15.05</td>
<td>+2.87</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>M 0.0544</td>
<td>0.0053</td>
<td>0.0490</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV -5.42</td>
<td>-19.45</td>
<td>-3.75</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>M 0.0522</td>
<td>0.0055</td>
<td>0.0467</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV +13.56</td>
<td>+5.34</td>
<td>+14.55</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>M 0.0643</td>
<td>0.0071</td>
<td>0.057</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV +9.12</td>
<td>+8.63</td>
<td>+9.18</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>M 0.0627</td>
<td>0.0087</td>
<td>0.0539</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV +34.30</td>
<td>+40.20</td>
<td>+33.59</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>PV +30.98</td>
<td>+71.26</td>
<td>+26.17</td>
<td></td>
</tr>
</tbody>
</table>

\( M = \) Mean  
\( PV = \) Percent variation
Table - 4  Water and dry matter content of 30 day old cotyledons of \( M_1 \) generation of \( L. \ usitatissimum \) \( L. \) var. Mukta under different gamma-ray doses in terms of fresh weight.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Water content/g</th>
<th>PV</th>
<th>Dry matter content/g</th>
<th>PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.8933</td>
<td>-</td>
<td>0.1066</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>0.9102</td>
<td>+1.89</td>
<td>0.0897</td>
<td>-15.86</td>
</tr>
<tr>
<td>50</td>
<td>0.9091</td>
<td>+1.77</td>
<td>0.0908</td>
<td>-14.84</td>
</tr>
<tr>
<td>75</td>
<td>0.9010</td>
<td>+0.86</td>
<td>0.0989</td>
<td>-7.24</td>
</tr>
<tr>
<td>100</td>
<td>0.8937</td>
<td>+0.04</td>
<td>0.1062</td>
<td>-0.36</td>
</tr>
<tr>
<td>125</td>
<td>0.8886</td>
<td>-0.52</td>
<td>0.1113</td>
<td>+4.37</td>
</tr>
<tr>
<td>150</td>
<td>0.8605</td>
<td>-3.67</td>
<td>0.1394</td>
<td>+30.73</td>
</tr>
</tbody>
</table>

PV = Percent variation
above, promote dry matter accumulation in cotyledons, while the lower doses like 25 and 50 krad treatments do not do so.

The water content of cotyledonary leaves on comparison has revealed that all the treated progenies have higher water content per unit area of cotyledonary leaf than the control, excepting 50 krad treatment in which a slight decrease of 3.75% has been recorded compared to that of control (Table-3). When the water content of leaves was calculated on weight to weight basis, it was found that, excepting the two higher doses (125 and 150 krad), in all the other treatments the plants have shown higher water content per gm of fresh leaf (Table-4). Similarly, the dry matter content when analysed on weight to weight basis, it has been found that there is a gradual decrease in the dry mass percentage of cotyledonary leaves from 25 krad to 100 krad treatment, while in 125 and 150 krad treatments there has been an increase in the dry mass content compared to that of control.

M₂ generation:- The cotyledonary expansion has been studied in M₂ generation based on 50 samples per treatment. It has been found that, in second generation, the cotyledonary area of treated progenies does not differ significantly compared to that of control, under all treatments, except that of 100 and 150 krad doses. The per cent variation analysis has revealed that there is a marginal decrease in 25, 50, 75 and 125 krad treatments
and a significant decrease in 100 krad treatment, while in 150 krad treatment there is a significant increase in area of cotyledons over that of control (Table-5).

Analysis of coefficient of variation has revealed that the treated progenies show a higher value of coefficient of variation over that of control under all treatments indicating that the variation induced by ionizing radiations lasts even in the second generation.

The weight analysis of cotyledons of the different progenies and that of control has shown that they do not differ to a significant level, although they vary apparently from one another. However the progeny of 150 krad treatment has shown that fresh weight of cotyledons to be heavier than that of control as well as of other treated progenies (Table-6).

The analysis of coefficient of variation with regard to fresh weight of cotyledons in the M₂ generation has shown that all the treated progenies have a higher value than that of control, except that of 25 krad dose in which almost a similar value of CV has been recorded as that of control (Table-6).

The dry weight analysis of cotyledons in M₂ generation has demonstrated again that there has been no significant difference in the dry matter content of M₂ generation between the control plants and that of treated ones except the 150 krad dose
Table - 5  Cotyledonary area of M₂ generation of *L. usitatissimum* L. var. Mukta after 30 days of sowing under different gamma ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Area of cotyledon in cm²</th>
<th>PV</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.990 ±0.2041</td>
<td></td>
<td>20.62</td>
</tr>
<tr>
<td>25</td>
<td>0.958 ±0.2121</td>
<td>-3.23</td>
<td>22.15</td>
</tr>
<tr>
<td>50</td>
<td>0.946 ±0.2517</td>
<td>-4.44</td>
<td>26.61</td>
</tr>
<tr>
<td>75</td>
<td>0.972 ±0.2452</td>
<td>-1.81</td>
<td>25.23</td>
</tr>
<tr>
<td>100</td>
<td>0.907* ±0.2644</td>
<td>-8.37</td>
<td>29.15</td>
</tr>
<tr>
<td>125</td>
<td>0.964 ±0.2307</td>
<td>-2.62</td>
<td>23.93</td>
</tr>
<tr>
<td>150</td>
<td>1.056* ±0.3742</td>
<td>+6.66</td>
<td>35.44</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.061</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Significant at 5% level
± = Standard deviation
PV = Percent variation
CV = Coefficient of variation
L.S.D. = Least significant difference
Table - 6  Fresh and dry weight (g) of 50 cotyledons of 30 days old stage of M2 generation of L. usitatissimum L. var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Fresh Weight</th>
<th>Dry Weight</th>
<th>PV</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.520</td>
<td>0.191</td>
<td>-</td>
<td>6.53</td>
</tr>
<tr>
<td></td>
<td>±0.1645</td>
<td>±0.0115</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>2.310</td>
<td>0.860</td>
<td>-8.33</td>
<td>6.48</td>
</tr>
<tr>
<td></td>
<td>±0.1497</td>
<td>±0.0129</td>
<td>-2.61</td>
<td>6.97</td>
</tr>
<tr>
<td>50</td>
<td>2.302</td>
<td>0.175</td>
<td>-8.65</td>
<td>7.21</td>
</tr>
<tr>
<td></td>
<td>±0.1660</td>
<td>±0.0131</td>
<td>-8.37</td>
<td>7.53</td>
</tr>
<tr>
<td>75</td>
<td>2.307</td>
<td>0.180</td>
<td>-8.45</td>
<td>6.98</td>
</tr>
<tr>
<td></td>
<td>±0.1611</td>
<td>±0.0126</td>
<td>-5.75</td>
<td>7.00</td>
</tr>
<tr>
<td>100</td>
<td>2.553</td>
<td>0.206</td>
<td>+1.30</td>
<td>7.83</td>
</tr>
<tr>
<td></td>
<td>±0.1999</td>
<td>±0.0163</td>
<td>+7.32</td>
<td>7.95</td>
</tr>
<tr>
<td>125</td>
<td>2.405</td>
<td>0.208</td>
<td>-4.563</td>
<td>9.65</td>
</tr>
<tr>
<td></td>
<td>±0.2322</td>
<td>±0.0210</td>
<td>+8.90</td>
<td>10.10</td>
</tr>
<tr>
<td>150</td>
<td>2.794*</td>
<td>0.226*</td>
<td>+10.87</td>
<td>10.34</td>
</tr>
<tr>
<td></td>
<td>±0.2891</td>
<td>±0.0255</td>
<td>+18.32</td>
<td>11.28</td>
</tr>
</tbody>
</table>

L.S.D. at 5% level  0.2624  0.0341

* = Significant at 5% level
± = Standard deviation
PV = Percent variation
CV = Coefficient of variation
L.S.D. = Least significant difference
in which a significant increase in dry mass value has been recorded over that of control and other treated progenies (Table-6).

The CV analysis of the different populations has revealed that all the treated progenies show a higher value than that of control, with respect to dry matter content in cotyledons.

The fresh weight of cotyledons in respect of unit area has been analysed in the different progenies. It has been found that the fresh weight of cotyledons per cm$^2$ area differs to some extent from that of control within a range of 1.984 to 10.569% both ways. There is a decrease under 25, 50, 75 and 125 krad treatments and an increase under 100 and 150 krad treatments as compared to control. The dry weight distribution/cm$^2$ area of cotyledons has shown on analysis that there is an increase of dry matter content under high intensity treatments (100, 125 and 150 krad). In the lower doses ranging from 25 to 75 krad there is a decrease in the dry matter content of cotyledons per cm$^2$ area, as compared to control (Table-7).

A similar analysis of water content per unit area of cotyledonary leaves has shown that the plant raised under 100 and 150 krad treatments showed an increase in water content per unit area of cotyledons, while the others have recorded a decrease compared to control (Table-7).
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weight in g per cm²</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fresh</td>
<td>Dry</td>
<td>Water content</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>0.0509</td>
<td>0.0038</td>
<td>0.0470</td>
</tr>
<tr>
<td>PV</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>0.0482</td>
<td>0.0038</td>
<td>0.0443</td>
</tr>
<tr>
<td>PV</td>
<td></td>
<td>-5.26</td>
<td>-0.64</td>
<td>-5.78</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>0.0486</td>
<td>0.0036</td>
<td>0.0449</td>
</tr>
<tr>
<td>PV</td>
<td></td>
<td>-4.40</td>
<td>-4.12</td>
<td>-4.44</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>0.0474</td>
<td>0.0037</td>
<td>0.0437</td>
</tr>
<tr>
<td>PV</td>
<td></td>
<td>-6.75</td>
<td>-4.01</td>
<td>-7.00</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>0.0562</td>
<td>0.0045</td>
<td>0.0517</td>
</tr>
<tr>
<td>PV</td>
<td></td>
<td>+10.56</td>
<td>+17.13</td>
<td>+10.01</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>0.0498</td>
<td>0.0043</td>
<td>0.0455</td>
</tr>
<tr>
<td>PV</td>
<td></td>
<td>-1.98</td>
<td>+11.84</td>
<td>-3.13</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>0.0529</td>
<td>0.0042</td>
<td>0.0486</td>
</tr>
<tr>
<td>PV</td>
<td></td>
<td>+3.94</td>
<td>+10.93</td>
<td>+3.35</td>
</tr>
</tbody>
</table>

M = Mean
PV = Percent variation
Table - 8 Water and dry matter content of 30 days old cotyledons of $M_2$ generation of *L. usitatissimum* L. var. Mukta under different gamma-ray doses in terms of fresh weight.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Water content/g.</th>
<th>PV</th>
<th>Dry matter content/g.</th>
<th>PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.9242</td>
<td>-</td>
<td>0.0758</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>0.9194</td>
<td>-0.51</td>
<td>0.0805</td>
<td>+6.22</td>
</tr>
<tr>
<td>50</td>
<td>0.9239</td>
<td>-0.02</td>
<td>0.0760</td>
<td>+0.30</td>
</tr>
<tr>
<td>75</td>
<td>0.9219</td>
<td>-0.24</td>
<td>0.0780</td>
<td>+2.94</td>
</tr>
<tr>
<td>100</td>
<td>0.9197</td>
<td>-0.48</td>
<td>0.0803</td>
<td>+5.93</td>
</tr>
<tr>
<td>125</td>
<td>0.9135</td>
<td>-1.15</td>
<td>0.0864</td>
<td>+14.10</td>
</tr>
<tr>
<td>150</td>
<td>0.9191</td>
<td>-0.55</td>
<td>0.0808</td>
<td>+6.71</td>
</tr>
</tbody>
</table>

PV = Percent variation
The water content of cotyledonary leaves of $M_2$ generation, when compared by weight to weight basis, it has been found that it varies from 0.024 to 1.156% in the different treated progenies compared to that of control. But in all cases, the water content recorded a decrease compared to that of control per gm of fresh cotyledons (Table-8). A similar analysis of dry mass content per gm of fresh cotyledons has revealed that there is a positive increase in the dry mass content of cotyledons over that of control to an extent of 0.303 to 14.102%, the maximum being under 125 krad treatment and the minimum in 50 krad treatment (Table-8).

$M_3$ generation: The cotyledonary expansion has also been studied in $M_3$ generation following the same procedure adopted for the $M_1$ and $M_2$ generations. Area of cotyledons on comparison has shown a decrease under all treatments compared to that of control, excepting 50 krad treatment in which it has been found to be the same as in the control. The difference in size on statistical analysis among the different treatments has shown that only in one case (125 krad) it is significantly different from that of control, whereas in others the size variation does not go to an extent of a significant level.

The per cent variation analysis has shown that the cotyledonary size varies from 0.18 to 10.05% in the different treatments compared to control (Table-9), the maximum being in 125 krad treatment and the minimum in 75 krad.
Table 9  Cotyledonal area of M₃ generation of
L. usitatissimum L. var. Mukta after 30 days
of sowing under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Area of cotyledon in cm²</th>
<th>PV</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1.000 ±0.2094</td>
<td>-</td>
<td>20.94</td>
</tr>
<tr>
<td>25</td>
<td>0.905 ±0.1792</td>
<td>-9.50</td>
<td>19.80</td>
</tr>
<tr>
<td>50</td>
<td>1.000 ±0.2274</td>
<td>0.0</td>
<td>22.74</td>
</tr>
<tr>
<td>75</td>
<td>0.998 ±0.2164</td>
<td>-0.18</td>
<td>21.68</td>
</tr>
<tr>
<td>100</td>
<td>0.940 ±0.2317</td>
<td>-5.91</td>
<td>24.63</td>
</tr>
<tr>
<td>125</td>
<td>0.899* ±0.2150</td>
<td>-10.05</td>
<td>23.91</td>
</tr>
<tr>
<td>150</td>
<td>0.918 ±0.1969</td>
<td>-8.14</td>
<td>21.44</td>
</tr>
</tbody>
</table>

L.S.D. at 5% level 0.095

* = Significant at 5% level
± = Standard deviation
PV = Percent variation
CV = Coefficient of variation
L.S.D. = Least significant difference
The coefficient of variation analysis has shown that the variation within the population under different treatments is very close to each other and that of control, indicating that the induced variation has almost vanished in the third generation.

Fresh weight analysis of variation in third generation has revealed that in the treated progenies there has been a decrease under all treatments but to a significant level only under 25, 100, 125 and 150 krad treatments. The per cent variation of fresh weight indicates that it varies from 4.094% to 44.596%, the maximum being in 125 krad treatment and the minimum in 50 krad treatment. The analysis of variation within the population has demonstrated that there is not much of variation in the treated populations and the control (Table-10).

Dry weight analysis of the cotyledons has revealed that in the treated progenies the dry matter content decreases compared to control but to a significant level only under 25, 75 and 125 krad treatments. The per cent variation of cotyledonary dry mass, has shown that its decrease varies from 3.174 to 26.190% in the treated materials compared to control, the maximum being under 25 krad treatment and the minimum in the 50 krad treatment (Table-10).

The CV analysis regarding the dry mass content of cotyledons has also shown a minimum variation in the different treated plants compared to control, indicating the induced variation has almost vanished in the third generation (Table-10).
Table 10: Fresh and dry weight (g) of 50 cotyledons of 30 day old stage of M\textsubscript{2} generation of \textit{L. usitatissimum} L. var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Fresh weight</th>
<th>Dry weight</th>
<th>PV</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.711</td>
<td>±0.1723</td>
<td>0.252</td>
<td>±0.0164</td>
<td>6.54</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.705*</td>
<td>±0.1132</td>
<td>0.186*</td>
<td>±0.0135</td>
<td>6.64</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td>-37.10</td>
<td>7.28</td>
</tr>
<tr>
<td>2.600</td>
<td>±0.1815</td>
<td>0.244</td>
<td>±0.0182</td>
<td>7.46</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td>-4.09</td>
<td>6.98</td>
</tr>
<tr>
<td>75</td>
<td>±0.1618</td>
<td>0.192*</td>
<td>±0.0146</td>
<td>7.61</td>
</tr>
<tr>
<td>2.310</td>
<td></td>
<td></td>
<td>-14.79</td>
<td>7.00</td>
</tr>
<tr>
<td>100</td>
<td>±0.1581</td>
<td>0.206</td>
<td>±0.0141</td>
<td>6.88</td>
</tr>
<tr>
<td>1.502*</td>
<td>±0.0944</td>
<td>0.190*</td>
<td>±0.0126</td>
<td>6.28</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td></td>
<td>-44.59</td>
<td>6.65</td>
</tr>
<tr>
<td>2.000*</td>
<td>±0.1421</td>
<td>0.208</td>
<td>±0.0149</td>
<td>7.20</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td></td>
<td>-26.22</td>
<td>7.10</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.5479</td>
<td></td>
<td>0.0463</td>
<td></td>
</tr>
</tbody>
</table>

* = Significant at 5% level  
± = Standard deviation  
PV = Percent variation  
CV = Coefficient of variation  
L.S.D. = Least significant difference
The analysis of fresh weight in relation to area of cotyledons has shown that the fresh weight of cotyledons shows a decrease from that of control in all the treated progenies per cm² area of cotyledons. The per cent variation worked out in this regard has revealed that it varies from 4.091 to 38.417% among the treated progenies compared to control. The maximum variation has been recorded under 125 krad treatment and this was followed by a 25 krad treatment, while the minimum has been found in 50 krad treatment (Table-11). A similar dry weight analysis in relation to cotyledonary area has shown that under all treatments there has been a decrease in the dry mass content per cm² area of cotyledon. The maximum variation has been found under 75 krad treatments. This has been found to be followed by 25 krad, 125 krad, 100 krad, 150 krad and 50 krad treatments. The water content of cotyledons per cm² area also has shown that the control contains more water than the treated ones. In this connection, the highest percentage of variation has been found in 125 krad treatment. This was found to be followed by 25, 150, 100, 75 and 50 krad treatment.

The water content of cotyledons has also been analysed on weight basis per gm of fresh material. This analysis has shown that the treated materials have lesser water content than the control under all treatments excepting 75 krad in which there is a slight rise to an extent of 1.084% over that of control (Table-12).
Table - 11 Fresh weight, dry weight and water content per unit area of 30 day old cotyledons of $M_3$ generation of *L. usitatissimum* L. var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weight in g per cm$^2$</th>
<th>Fresh</th>
<th>Dry</th>
<th>Water content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>0.0542</td>
<td>0.0050</td>
<td>0.0491</td>
<td></td>
</tr>
<tr>
<td>PV</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>M 0.0376</td>
<td>0.0041</td>
<td>0.0335</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV -30.52</td>
<td>-18.45</td>
<td>-31.76</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>M 0.0520</td>
<td>0.0048</td>
<td>0.0471</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV -4.09</td>
<td>-3.17</td>
<td>-4.18</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>M 0.0462</td>
<td>0.0038</td>
<td>0.0424</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV -14.64</td>
<td>-23.69</td>
<td>-13.72</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>M 0.0447</td>
<td>0.0043</td>
<td>0.0403</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV -17.55</td>
<td>-13.13</td>
<td>-18.01</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>M 0.0333</td>
<td>0.0042</td>
<td>0.0291</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV -38.41</td>
<td>-16.19</td>
<td>-40.69</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>M 0.0435</td>
<td>0.0045</td>
<td>0.0391</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV -19.69</td>
<td>-10.15</td>
<td>-20.45</td>
<td></td>
</tr>
</tbody>
</table>

M = Mean
PV = Percent variation
Table 12 Water and dry matter content of 30 day old cotyledons of M₃ generation of L. usitatissimum L. var. Mukta under different gamma-ray doses in terms of fresh weight.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Water content/g</th>
<th>PV</th>
<th>Dry matter content/g</th>
<th>PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.9070</td>
<td>-</td>
<td>0.0929</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>0.8909</td>
<td>-1.77</td>
<td>0.1091</td>
<td>+17.36</td>
</tr>
<tr>
<td>50</td>
<td>0.9061</td>
<td>-0.09</td>
<td>0.0938</td>
<td>+ 0.95</td>
</tr>
<tr>
<td>75</td>
<td>0.9168</td>
<td>+1.08</td>
<td>0.0831</td>
<td>-10.58</td>
</tr>
<tr>
<td>100</td>
<td>0.9020</td>
<td>-0.55</td>
<td>0.0979</td>
<td>+ 5.37</td>
</tr>
<tr>
<td>125</td>
<td>0.8735</td>
<td>-3.69</td>
<td>0.1265</td>
<td>+36.08</td>
</tr>
<tr>
<td>150</td>
<td>0.8960</td>
<td>-1.21</td>
<td>0.1040</td>
<td>+11.87</td>
</tr>
</tbody>
</table>

PV = Percent variation
The dry matter content per gm of fresh cotyledons, on the other hand, has shown that in all the treated progenies except 75 krad it is higher than control. In this connection 125 krad treatment showed the highest variation which has been recorded to be 36.08% (Table-12). The 25 krad treatment has also shown a fairly high percentage of variation over that of control i.e. 17.362%. The minimum variation has been recorded in the progeny which has been raised under 50 krad treatment (Table-12).

Figure-7 shows that cotyledonary area of the different progenies under different treatments. It is clear from the figure that in $M_1$ generation the area of cotyledon is consistently larger than in the other two generations under all treatments, except in the two high intensity doses of 125 and 150 krad treatments, in which the cotyledons of $M_2$ generation have shown a greater area than in $M_1$ and $M_3$ generations.

Figure-8 shows the fresh and dry weight of cotyledons on a comparative basis in the different generations. The fresh weight had shown a decreasing trend from the first to third generation except in 50 krad treatment in which the third generation has recorded a higher variation than the first and second. Similarly the dry weight of cotyledons also followed the same trend as that of the fresh weight with the exception of 50 krad treatment.
FIG. 7
**Fig. 8**

Graph showing the fresh and dry weight of 50 cotyledons over different doses in krad:

- **Fresh weight (CM₁)**
- **Dry weight (CM₁)**
- **Fresh weight (CM₂)**
- **Dry weight (CM₂)**
- **Fresh weight (CM₃)**
- **Dry weight (CM₃)**

Doses in krad: 0, 25, 50, 75, 100, 125, 150.
Figure-9 shows the dry matter distribution per cm² area of cotyledonary leaf in the different generations. Here also M₁ generation recorded a higher value than in M₂ and M₃ generations, under all treatments excepting that of 150 krad in which the third generation showed the highest value compared to the other two generations. The figure-9 also shows the water content of cotyledons per unit area. The trend goes almost similar to that of dry matter of cotyledonary leaf per cm² area. Here also in 50 krad treatment in M₃ generation shows the higher water content than M₁ and M₂ generation.

Figure-10 shows the water content of cotyledons per gm of fresh weight. The M₂ generation showed a higher water content than the M₁ and M₃ generations under all treatments including of control, while the dry matter content of cotyledons per gm of fresh leaf show just a reverse trend. The M₂ generation showed the lowest dry matter content per gm of cotyledonary leaf compared to that of other two generations. In M₁ generation 25, 50 and 125 krad treatment the dry matter content was found to be less compared to that of M₃ generations, while under 75, 100 and 150 krad treatments the amount of dry matter content was found to be higher than the other two generations. Under 25 and 125 krad treatments a highest value for dry matter was found to be in M₃ generation while in the rest of the cases the highest amount was found to be in M₁ generation.
Root elongation:

The rate of root elongation was studied at fortnightly intervals throughout the experimental period of 120 days.

In M₁ generation the roots of untreated plants showed better growth at all stages. The treated plants on the other hand, showed significantly shorter root length compared to that of control at all levels of their growth, except the 25 krad treatment in which the root length did not show any significant difference with that of control at its 30 day old stage. Table-13 shows the root length of plants at different stages of their growth. It is clear from the data obtained that there is a gradual fall in root length under different treatments depending on the intensity of doses at all levels of observations. Figure-11 indicates the rate of elongation of root under different treatments. The progenies of all the treatments have shown, in the first 15 days higher rate of growth than their subsequent stages. The root growth in 50 krad treatment, on the otherhand, showed a rise at the third stage before it fell at the fourth, while the progenies of 100 and 150 krad treatments followed a continuous fall from the first to the last stage of growth analysed.

The root length of the different progenies of the treated seeds was compared with that of control. The per cent variation showed a general increasing trend with the increasing intensity of ionizing radiation involved in the treatment (Figure-12).
Table - 13  Root length (cm) in M₁ generation of L. usitatissimum L. var. Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Root length in cm</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>5.50</td>
<td>7.000</td>
</tr>
<tr>
<td></td>
<td>±0.5929</td>
<td>±0.883</td>
</tr>
<tr>
<td>25</td>
<td>3.50*</td>
<td>6.00</td>
</tr>
<tr>
<td></td>
<td>±0.447</td>
<td>±1.074</td>
</tr>
<tr>
<td>50</td>
<td>3.50*</td>
<td>4.50*</td>
</tr>
<tr>
<td></td>
<td>±0.707</td>
<td>±0.632</td>
</tr>
<tr>
<td>75</td>
<td>3.0*</td>
<td>3.80*</td>
</tr>
<tr>
<td></td>
<td>±0.916</td>
<td>±0.624</td>
</tr>
<tr>
<td>100</td>
<td>2.83*</td>
<td>4.20*</td>
</tr>
<tr>
<td></td>
<td>±0.919</td>
<td>±0.748</td>
</tr>
<tr>
<td>125</td>
<td>2.66*</td>
<td>3.60*</td>
</tr>
<tr>
<td></td>
<td>±0.287</td>
<td>±0.734</td>
</tr>
<tr>
<td>150</td>
<td>2.60*</td>
<td>3.30*</td>
</tr>
<tr>
<td></td>
<td>±0.20</td>
<td>±0.632</td>
</tr>
</tbody>
</table>

L.S.D. at 5% level |
| 1.2054 | 1.4075 | 1.2537 | 1.6804 | 1.3650 |

± = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level.
The coefficient of variation calculated to estimate the variation within the progeny has shown that it is lower in control compared to that of the treated progenies. There is an increasing trend in the value of CV with an increasing intensity of dose. However, at the 3rd and 4th stages of growth the progenies of 25 and 50 krad treatments showed lower value of CV than that of control. Further under all treatments the coefficient of variation within the population showed a consistent decrease with the growing age of plants, with a slight departure in certain cases, especially under high doses. For instance, under 150 krad treatment the 2nd stage observation on the root length elongation had shown a lower value of CV than at the other stages of growth. Similarly 75 and 100 krad doses showed slightly lower values of CV at their 2nd stage and 125 krad at its 3rd stage of growth (Table-14).

The rate of root elongation has been studied in $M_2$ generation at fortnightly intervals as in the case of $M_1$ generation. Table-15 summarises the results obtained. The comparison of root length of different treated materials with that of control has revealed that at the 2 week stage all the treated progenies showed a significantly lesser rate of root elongation except that of 75 krad treatment in which the root length measured comparable to that of control. In 30 day old seedlings root length of $M_2$
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Control</td>
<td>10.78</td>
</tr>
<tr>
<td>25</td>
<td>12.77</td>
</tr>
<tr>
<td>50</td>
<td>20.20</td>
</tr>
<tr>
<td>75</td>
<td>30.55</td>
</tr>
<tr>
<td>100</td>
<td>32.47</td>
</tr>
<tr>
<td>125</td>
<td>30.78</td>
</tr>
<tr>
<td>150</td>
<td>26.96</td>
</tr>
</tbody>
</table>
generation showed a significant difference under 50, 75, 100 and 150 krad treatments, while the progenies of 25 and 125 krad treatments did not show any significant variation in root length with that of control. A similar comparison of root length in the subsequent intervals of observation has revealed that it did not vary to a significant level in any of the treatments compared to control.

Figure-11 indicates the rate of root growth under different treatments at different stages of growth. It is worth noting that as in the first generation the second generation seedling also showed a high rate of growth during the first 15 days of their life under all treatments, including that of control. The rate of root growth, in general, has shown a considerable fall during the second stage. The third stage readings again had shown that rate of growth has increased under all treatments, while in control it decreased to some extent. During the fourth stage observation, a further increase in the rate of root elongation has been observed in the first three treatments involving 25, 50 and 75 krad doses. The high intensity doses like 100, 125 and 150 krad showed considerable decrease in elongation rate at this stage while the control showed a slight recovery from its previous stage.
Table - 15  Root length (cm) in M$_2$ generation of L. *usitatissimum* L. var. Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Root length in cm.</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.66</td>
<td>7.26</td>
</tr>
<tr>
<td></td>
<td>±1.456</td>
<td>±1.04</td>
</tr>
<tr>
<td>25</td>
<td>5.53</td>
<td>6.83</td>
</tr>
<tr>
<td></td>
<td>±0.321</td>
<td>±0.803</td>
</tr>
<tr>
<td>50</td>
<td>5.33*</td>
<td>5.83*</td>
</tr>
<tr>
<td></td>
<td>±0.524</td>
<td>±0.667</td>
</tr>
<tr>
<td>75</td>
<td>6.06</td>
<td>6.83</td>
</tr>
<tr>
<td></td>
<td>±0.991</td>
<td>±0.667</td>
</tr>
<tr>
<td>100</td>
<td>4.50*</td>
<td>5.10*</td>
</tr>
<tr>
<td></td>
<td>±0.632</td>
<td>±0.489</td>
</tr>
<tr>
<td>125</td>
<td>5.97</td>
<td>6.66</td>
</tr>
<tr>
<td></td>
<td>±0.878</td>
<td>±0.531</td>
</tr>
<tr>
<td>150</td>
<td>5.46</td>
<td>5.96*</td>
</tr>
<tr>
<td></td>
<td>±0.454</td>
<td>±0.665</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>1.2603</td>
<td>0.90317</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
Table -16  Coefficient of variation for root length of \( N_2 \) generation of \( L. \ usitatissimum \) \( L. \) var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Control</td>
<td>21.87</td>
</tr>
<tr>
<td>25</td>
<td>5.804</td>
</tr>
<tr>
<td>50</td>
<td>9.83</td>
</tr>
<tr>
<td>75</td>
<td>16.38</td>
</tr>
<tr>
<td>100</td>
<td>14.05</td>
</tr>
<tr>
<td>125</td>
<td>14.71</td>
</tr>
<tr>
<td>150</td>
<td>8.29</td>
</tr>
</tbody>
</table>
Analysis of coefficient of variation in the population of treated progenies as well as of control has revealed that the treated progenies are more stable than the control at all stages of their growth expression, with minor deviation in some cases. The progenies of 50, 75 and 100 krad treatments showed deviation from the general trend, in having slightly higher CV than that of control at the 3rd stage growth expression (Table-16).

Table-17 shows the root length of M₃ progenies of the different treatments and control at different stages of growth. Root length did not show any significant variation between control and treated progenies at all levels of observation except in two cases of 75 krad and 100 krad treatments in which the difference being significant at the 4th and 2nd stages respectively.

The rate of growth of root length under different treatments has been shown in Figure-11. Like the first two generations, M₃ generation also recorded high rate of root elongation in the first 15 days. Under high intensity doses, the rate of root elongation showed a continuous fall with the growing age of plants except at the 4th stage in which progenies of 100 and 125 krad treatments showed a slight increase. The progenies of 50 krad treatment showed a similarity with that of control in their root length behaviour in having a poor rate of root length in the 2nd
stage followed by a better growth in 3rd stage which was in turn followed by a fall. The 25 krad treatment showed a separate trend in having a gradual fall followed by a rise at its last stage of growth.

The per cent variation analysis of root length between the control and the treated progenies has shown the variation is not high in the 3rd generation (Figure-12).

Analysis of variance at the population level of different treatments have shown that during the first stage of growth, the progenies of 50 and 125 krad treatments recorded higher value of CV while the rest exhibited lower values (Table-18). During the 2nd stage, all the treated progenies except that of 125 krad showed a lower CV value. During the 3rd stage all the treated progenies recorded a lower value compared to control, while during the 4th stage all the treated progenies had a higher value of CV compared to control, the highest being in 25 krad treatments (Table-18).

The graphs in Figure-11 strikes a comparison of the rate of root elongation at different growth intervals of all the three generations. It becomes clear from the figure that the seedlings grow faster in the first 15 days in all the three generations, the $M_4$ being the slowest and $M_3$ being the fastest in all the three generations. This fast rate of growth in the root elongation is subsequently followed by a sharp fall in the next 15 days. In the
Table - 17  Root length (cm) in M₃ generation of  
*L. usitatissimum* L. var. Mukta under different  
gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Root length in cm.</th>
<th>Weeks after generation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Control</td>
<td>6.16</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>±0.891</td>
<td>±1.218</td>
</tr>
<tr>
<td>25</td>
<td>6.83</td>
<td>7.60</td>
</tr>
<tr>
<td></td>
<td>±0.694</td>
<td>±1.116</td>
</tr>
<tr>
<td>50</td>
<td>5.50</td>
<td>6.43</td>
</tr>
<tr>
<td></td>
<td>±1.183</td>
<td>±0.974</td>
</tr>
<tr>
<td>75</td>
<td>5.30</td>
<td>6.30</td>
</tr>
<tr>
<td></td>
<td>±0.509</td>
<td>±0.400</td>
</tr>
<tr>
<td>100</td>
<td>7.30</td>
<td>8.40*</td>
</tr>
<tr>
<td></td>
<td>±1.077</td>
<td>±0.489</td>
</tr>
<tr>
<td>125</td>
<td>5.4</td>
<td>6.16</td>
</tr>
<tr>
<td></td>
<td>±1.240</td>
<td>±1.201</td>
</tr>
<tr>
<td>150</td>
<td>5.65</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>±1.052</td>
<td>±1.125</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>1.3179</td>
<td>1.3879</td>
</tr>
</tbody>
</table>

† = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
Table - 18 Coefficient of variation for root length of M₃ generation of L. usitatissimum L. var. Mukta under different gamma-ray doses

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Control</td>
<td>14.46</td>
</tr>
<tr>
<td>25</td>
<td>10.16</td>
</tr>
<tr>
<td>50</td>
<td>21.50</td>
</tr>
<tr>
<td>75</td>
<td>9.60</td>
</tr>
<tr>
<td>100</td>
<td>14.75</td>
</tr>
<tr>
<td>125</td>
<td>22.96</td>
</tr>
<tr>
<td>150</td>
<td>18.61</td>
</tr>
</tbody>
</table>
third 15 days of growth the roots recorded a further but steady fall in their rate of root elongation. However, under 50 krad treatment the sharp fall of second 15 days is followed by a temporary rise in the next 15 days in all the three generations, and, this, in turn is followed by a decrease in M₁ and M₂ generations but in M₂ generation the rate of growth followed a further rise. Under 75 krad treatment the M₁ and M₂ generations showed a higher rate of root elongation at the fourth stage of observation, while the M₃ generation showed a reduced rate. Under 100 krad treatment, the behaviour of root growth differed in different generations. In M₁ generation the root elongation followed a continuous fall from second to the last stage. The second generation recorded a rise at the third stage to follow a slight decrease at the fourth. The third generation on the other hand showed the highest rate of growth in the first 15 days and this was followed by a decline in root elongation up to the third stage and ultimately it recorded a slight increase at the fourth stage compared to the first generation. The behaviour of 150 krad progeny followed a more or less similar pattern as that of 100 krad treatment in the different generations (Figure-11F). Under 125 krad treatment M₁ generation followed a pattern of 75 krad treatment, the M₂ generation followed a pattern compared to that of 150 krad treatment, while the M₃ generation followed its own course to record an initial steep rise followed by a sharp fall which was again followed by a rise.
In general the pattern of growth of the different generations under all treatments followed certain general course that is, to say in the first 15 days the rate of growth showed an increasing order with the order of generation and the rate of fall in the second 15 days also followed a similar order with the order of generation, the slowest being the first.
 CONTROL
- M\textsubscript{1} GENERATION
- M\textsubscript{2} GENERATION
- M\textsubscript{3} GENERATION

25 KRAD

100 KRAD

50 KRAD

75 KRAD

125 KRAD

150 KRAD

WEEKS AFTER GERMINATION

FIG. II
FIG. 12

- M₁ GENERATION
- M₂ GENERATION
- M₃ GENERATION

PER CENT VARIATION IN ROOT LENGTH

DOSES IN KRAD

25  50  75  100  125  150
Shoot elongation:

**M₁ generation:** The shoot growth has been studied at different stages of growth at weekly intervals having 20 individuals serving as replicate for each treatment including control. Table-19 summarises the results obtained in the present investigation. In one week old seedlings, the height of plant is significantly short in all the treated progenies except that of 25 krad treatment in which the seedling height has fallen slightly short compared to control, but not being statistically significant at 5 per cent level. In the two week old seedlings, a similar comparison of seedling height has revealed that the trend follows the same course as in the one week old seedlings. In the three week old seedlings, the plants of 25 krad treatments slightly surpassed the height of control plants. But statistical analysis has shown that the difference is not significant at 5 per cent level. At this stage, the progenies of 50 krad treatment also showed an almost equal shoot height to that of control. However the seedlings under other treatments significantly differed in their height compared to that of control. Comparison of shoot length in four week old seedlings has revealed that the mean shoot length is shorter under all treatments compared to control excepting in the case of 25 krad treatment.
The five week old plants have shown that the mean shoot length to be shorter than that of control under all treatments without any exception. The same trend of results has also been obtained in six week old plants. However in 7 and 8 week old plants, the shoot axis, on comparison, has shown that the plants of 25 krad treatment do not differ in their mean shoot length with that of control. In 8 week old stage, the progenies of 50 krad treatment have shown an insignificant level of difference in shoot height with that of control. In rest of the treatments, the shoot length average differed significantly at 5 per cent level compared to control.

The growth analysis with regard to shoot height under the influence of different levels of ionizing radiations in the form of gamma-ray treatment has shown that the shoot length average depends on the intensity of the doses in a given growth stage. In general the plants raised out of seeds treated with gamma-rays showed a direct relationship with the intensity of radiation in all treatments. The higher is the intensity, higher happens to be its effect on shoot growth and, therefore, the shorter is the length average of the progeny. This trend of suppressing activity of ionizing radiations has been consistently displayed by the plants under different treatments at all stages of growth investigated, with minor fluctuations of insignificant nature occurring here and there (Table-19).
Table 19: Shoot length (cm) in M_1 generation of L. usitatissimum L. var Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Shoot length in cm (Weeks after germination)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>2.76 ± 0.169</td>
<td>7.34 ± 0.804</td>
<td>12.70 ± 1.088</td>
<td>17.12 ± 0.263</td>
<td>24.44 ± 0.894</td>
<td>32.62 ± 0.820</td>
<td>43.34 ± 1.136</td>
<td>43.39 ± 1.136</td>
<td>82.46 ± 4.318</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>2.62 ± 0.186</td>
<td>7.02 ± 0.532</td>
<td>13.67 ± 0.802</td>
<td>16.44 ± 1.683</td>
<td>21.86* ± 1.087</td>
<td>28.14* ± 1.583</td>
<td>41.25 ± 1.54</td>
<td>41.25 ± 1.54</td>
<td>74.40* ± 11.311</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>2.32* ± 0.201</td>
<td>5.33* ± 0.326</td>
<td>12.29 ± 1.249</td>
<td>14.36* ± 0.729</td>
<td>16.80* ± 1.616</td>
<td>22.96* ± 1.185</td>
<td>31.41* ± 1.084</td>
<td>40.69 ± 7.078</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>1.76* ± 0.152</td>
<td>3.87* ± 0.764</td>
<td>7.89* ± 0.827</td>
<td>12.57* ± 1.109</td>
<td>16.77* ± 0.922</td>
<td>22.21* ± 0.807</td>
<td>27.06* ± 2.25</td>
<td>34.22* ± 4.274</td>
<td>58.20* ± 9.601</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>1.69* ± 0.265</td>
<td>3.79* ± 0.751</td>
<td>7.73* ± 0.690</td>
<td>12.72* ± 1.048</td>
<td>16.77* ± 1.554</td>
<td>17.45* ± 2.354</td>
<td>23.11* ± 1.428</td>
<td>27.22* ± 1.389</td>
<td>53.13* ± 9.012</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>1.29* ± 0.206</td>
<td>2.76* ± 0.394</td>
<td>4.21* ± 1.055</td>
<td>6.57* ± 0.859</td>
<td>12.01* ± 0.747</td>
<td>12.82* ± 2.460</td>
<td>15.64* ± 1.528</td>
<td>21.07* ± 1.706</td>
<td>48.83* ± 6.259</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>1.25* ± 0.163</td>
<td>1.78* ± 0.255</td>
<td>2.43* ± 0.228</td>
<td>3.60* ± 0.589</td>
<td>5.16* ± 0.759</td>
<td>5.92* ± 1.352</td>
<td>7.4* ± 1.392</td>
<td>8.74* ± 1.545</td>
<td>48.66* ± 8.857</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td></td>
<td>0.247 ± 0.0842</td>
<td>0.8482 ± 1.0388</td>
<td>1.4551 ± 1.4346</td>
<td>2.6382 ± 2.2031</td>
<td>3.0215 ± 6.3020</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level.
The rate of shoot elongation has been studied at weekly intervals having 20 individuals under each treatment serving as replicates. The rate of shoot elongation of the plants under different treatments has been compared with that of control. The results obtained in this connection have been depicted in Figure-13A-F. It becomes clear from the Figure (13A) that the behaviour of shoot growth with respect to rate of shoot axis elongation follows more or less the same trend in the plants of 25 krad and control. The comparison of growth behaviour of control with that of 50 krad progeny shows that the latter after having a slightly higher rate at its 3 week stage, exhibited a consistently lesser rate of growth compared to control upto 7th week but at the 8th week stage, the treated plant maintained their steady growth rate while the control comes down to zero level to reach its reproductive phase (Figure-13B).

In the rest of the treatments the rate of shoot elongation followed the same trend in having a slow rate of growth compared to control in a proportion corresponding to that of intensity of dose. In the two highest doses the rate of shoot elongation never came up to the level of control in any of the observation period (Figure-13E and F).

The comparison of shoot height of the various treated progenies in \( M_1 \) generation with that of control has revealed that
Table 20  Coefficient of variation for shoot length of M₁ generation of L. usitatissimum L. var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6.13</td>
<td>10.95</td>
<td>8.56</td>
<td>1.53</td>
<td>3.65</td>
<td>2.51</td>
<td>2.62</td>
<td>2.62</td>
<td>5.23</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>7.11</td>
<td>7.58</td>
<td>5.87</td>
<td>10.23</td>
<td>10.69</td>
<td>5.62</td>
<td>3.73</td>
<td>3.73</td>
<td>15.20</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>8.68</td>
<td>9.34</td>
<td>2.65</td>
<td>8.69</td>
<td>4.33</td>
<td>7.03</td>
<td>3.77</td>
<td>2.66</td>
<td>11.07</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>8.62</td>
<td>19.71</td>
<td>10.48</td>
<td>8.82</td>
<td>5.49</td>
<td>3.63</td>
<td>8.33</td>
<td>12.48</td>
<td>16.49</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>15.69</td>
<td>19.79</td>
<td>8.92</td>
<td>8.24</td>
<td>9.66</td>
<td>13.48</td>
<td>6.17</td>
<td>5.10</td>
<td>16.96</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>16.00</td>
<td>14.27</td>
<td>25.05</td>
<td>13.06</td>
<td>6.21</td>
<td>19.18</td>
<td>9.76</td>
<td>8.09</td>
<td>12.81</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>13.04</td>
<td>14.31</td>
<td>9.37</td>
<td>16.34</td>
<td>14.68</td>
<td>22.84</td>
<td>18.81</td>
<td>17.67</td>
<td>18.20</td>
<td></td>
</tr>
</tbody>
</table>
they show lesser height under all treatments than the control plants except the 25 krad treatment in which the 3 week old seedlings surpass in height over control to a very marginal extent of 0.97 per cent (not significant statistically at 5 per cent level Table-19). In general per cent variation in shoot length followed a linear trend with that of the intensity of doses involved in the treatment. The widest variation being shown by the highest intensity dose of 150 krad treatment (Figure-14).

The analysis of coefficient of variation in regarded to this parameter has shown that the CV value happens to be consistently higher in all the treated progenies at all stages of growth compared to that of control excepting in two cases of 25 and 50 krad treatments in which at the 2nd and 3rd week stage a lesser value of CV has been obtained compared to control. The high value of CV in the treated progenies indicates that the ionizing radiations employed in the treatments have induced variations in regard to the trait studied. In general the degree of variation to be higher in high doses than in the lower ones. Further as the time passes the CV value tends to go down in a given treatment, but with minor fluctuations here and there (Table-20).

\( M_2 \) generation: The shoot growth in \( M_2 \) generation has also been studied at weekly intervals till the plants entered their reproductive phase, and later at the time of harvest, the height of the plants was recorded as final reading.
In one week old seedling the shoot height in $M_2$ generation has been noted not to differ from one another irrespective of the treatment, the progenies had undergone in their 1st generation excepting the highest dose of 150 krad in which the seedlings had shown a significantly high shoot length compared to control. The shoot length in two week old seedling recorded a significant decrease in shoot length in almost all the treatments with the exception of 100 and 150 krad treatments in which the stem height did not show any significant difference with that of control. In five week old plants with the exception of 25 krad treatment all the other treatments showed a shorter stem axis compared to control. In six and seven week old plants also, the length of shoot axis remained shorter in all the treatments than that of control, irrespective of the strength of radiation dose (Table-21). At the 8th week the growth stopped and the plants entered the reproductive phase.

The rate of shoot elongation at weekly intervals in the different treatments and control has shown that the rate of growth of the shoot axis varies at different stages of its growth of age of the plant in control as well as in the treated progenies. During the 1st week of its life the seedling grow slowly in all cases including the control. During this period the length of shoot axis remain more or less the same in control and in the
Table - 21  Shoot length (cm) in M₂ generation of *L. usitatissimum* L. var Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Shoot length in cm Weeks after germination</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>3.35 ± 1.01</td>
<td>9.95 ± 1.64</td>
<td>16.92 ± 2.83</td>
<td>22.37 ± 3.47</td>
<td>30.82 ± 5.21</td>
<td>45.77 ± 6.91</td>
<td>53.0 ± 8.2</td>
<td>82.46 ± 10.6</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>3.30 ± 0.98</td>
<td>9.15 ± 0.98</td>
<td>13.85 ± 2.88</td>
<td>18.97 ± 3.25</td>
<td>27.02 ± 4.3</td>
<td>36.10 ± 4.79</td>
<td>48.30 ± 5.4</td>
<td>80.63 ± 10.6</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>3.2 ± 1.55</td>
<td>8.17 ± 1.55</td>
<td>12.22 ± 2.58</td>
<td>16.00 ± 2.26</td>
<td>22.50 ± 2.95</td>
<td>29.85 ± 4.3</td>
<td>37.35 ± 5.6</td>
<td>74.93 ± 6.5</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>3.42 ± 1.08</td>
<td>8.55 ± 1.90</td>
<td>14.42 ± 3.22</td>
<td>17.75 ± 2.98</td>
<td>24.50 ± 4.28</td>
<td>31.20 ± 5.64</td>
<td>40.40 ± 7.3</td>
<td>73.8 ± 9.82</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>3.55 ± 1.87</td>
<td>9.24 ± 2.01</td>
<td>13.72 ± 2.64</td>
<td>17.62 ± 3.79</td>
<td>24.07 ± 6.08</td>
<td>31.95 ± 7.52</td>
<td>43.00 ± 9.2</td>
<td>79.20 ± 9.66</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>3.77 ± 1.31</td>
<td>9.15 ± 2.46</td>
<td>13.95 ± 2.99</td>
<td>18.30 ± 5.92</td>
<td>22.80 ± 7.17</td>
<td>32.80 ± 7.62</td>
<td>43.30 ± 9.2</td>
<td>71.9 ± 9.20</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>4.05 ± 1.33</td>
<td>9.90 ± 2.43</td>
<td>14.92 ± 3.71</td>
<td>19.20 ± 6.46</td>
<td>23.22 ± 11.22</td>
<td>31.70 ± 8.35</td>
<td>44.70 ± 9.52</td>
<td></td>
</tr>
</tbody>
</table>

L.S.D. at 5% level

| L.S.D. at 5% level | 0.4454 | 0.7554 | 1.2052 | 1.8679 | 3.232 | 4.141 | 4.2445 | 6.1586 |

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
treated progenies with the exception of 150 krad treatment in which the shoot growth surpassed all others. During the 2nd week all the treated progenies and the control showed a higher rate of shoot elongation. During the 3rd week a fall in the rate of growth of the shoot axis has been recorded in all the treated progenies excepting that of 75 krad and control. During the 4th week the falling rate in shoot elongation continued in all cases including that of control and 75 krad treatment. However in 5th week and in the subsequent weeks till the plants entered the reproductive phase, the rate of shoot elongation has been found to be high (Figure-13).

The variation of shoot height caused by the treatment has been analysed in the different treatments compared to that of control. It has been found that during the 1st week all the treated progenies excepting that of the first two doses recorded a higher shoot length compared to control but in the subsequent stages the control plant surpassed in stem height and all the treated progenies. Figure-14 shows the per cent variation in the different treated progenies at harvesting stage.

Table-22 shows that the results of analysis of variance within the population of 2nd generation raised under different treatments and untreated control. The CV value obtained on the basis of growth performance shows that it is in its close range.
Table - 22  Coefficient of variation for shoot length of M$_2$
generation of L. usitatissimum L. var. Mukta
under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>20.05</td>
<td>10.16</td>
<td>6.87</td>
<td>12.65</td>
<td>11.27</td>
<td>11.39</td>
<td>13.04</td>
<td>5.22</td>
</tr>
<tr>
<td>50</td>
<td>18.75</td>
<td>18.38</td>
<td>12.56</td>
<td>9.37</td>
<td>28.88</td>
<td>7.58</td>
<td>6.17</td>
<td>8.71</td>
</tr>
<tr>
<td>75</td>
<td>18.06</td>
<td>12.65</td>
<td>13.21</td>
<td>18.17</td>
<td>12.07</td>
<td>13.73</td>
<td>13.96</td>
<td>13.30</td>
</tr>
<tr>
<td>100</td>
<td>16.60</td>
<td>9.46</td>
<td>14.68</td>
<td>15.01</td>
<td>15.49</td>
<td>19.04</td>
<td>17.50</td>
<td>12.19</td>
</tr>
<tr>
<td>125</td>
<td>19.88</td>
<td>28.61</td>
<td>17.66</td>
<td>15.29</td>
<td>26.00</td>
<td>21.69</td>
<td>17.61</td>
<td>12.79</td>
</tr>
<tr>
<td>150</td>
<td>20.98</td>
<td>13.41</td>
<td>16.28</td>
<td>19.35</td>
<td>27.82</td>
<td>35.41</td>
<td>18.69</td>
<td>12.57</td>
</tr>
</tbody>
</table>
However during the 2nd week the variation range became a little high under 50 krad and 125 krad treatments compared to that of control. In the subsequent stages the treated progeny showed a higher CV value compared to control with minor fluctuations here and there.

\textit{M}_3 \textit{generation}: The growth analysis in terms of shoot axis elongation has been studied in the \textit{M}_3 generation. It has been found that the height of seedlings after a week's growth did not show any considerable variation in the different treated and untreated control. After two weeks growth, the seedlings of 100 krad, 125 krad and 150 krad treatments showed less amount of growth compared to that of control. In three weeks old seedlings the shoot height of all the treated plants remained shorter to that of control. During the 4th and 5th weeks performance, the treated progenies lagged behind control excepting 25 krad treatment in which no significant difference has been observed in shoot length. In 6 week old plants, the progenies of 25, 50 and 100 krad treatments have almost levelled their height to that of control, while the plants of 75, 125 and 150 krad treatments remained shorter than that of control. In the 7th week, excepting the two highest doses (125 and 150 krad), all the others have gone upto the rank of control in shoot height and in the 8th week all entered in the flowering stage (Table-23).
Table - 23  Shoot length (cm) in $M_2$ generation of L. usitatissimum L. var Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Shoot length in cm</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Control</td>
<td>3.05</td>
<td>9.1</td>
</tr>
<tr>
<td></td>
<td>±0.659</td>
<td>±1.374</td>
</tr>
<tr>
<td>25</td>
<td>3.2</td>
<td>8.52</td>
</tr>
<tr>
<td></td>
<td>±0.556</td>
<td>±1.108</td>
</tr>
<tr>
<td>50</td>
<td>3.24</td>
<td>8.87</td>
</tr>
<tr>
<td></td>
<td>±0.458</td>
<td>±1.171</td>
</tr>
<tr>
<td>75</td>
<td>3.49</td>
<td>8.4</td>
</tr>
<tr>
<td></td>
<td>±0.420</td>
<td>±0.994</td>
</tr>
<tr>
<td>100</td>
<td>3.17</td>
<td>8.02*</td>
</tr>
<tr>
<td></td>
<td>±0.637</td>
<td>±1.166</td>
</tr>
<tr>
<td>125</td>
<td>2.81</td>
<td>7.45*</td>
</tr>
<tr>
<td></td>
<td>±0.646</td>
<td>±0.906</td>
</tr>
<tr>
<td>150</td>
<td>3.08</td>
<td>8.05*</td>
</tr>
<tr>
<td></td>
<td>±0.564</td>
<td>±0.974</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.3579</td>
<td>0.7246</td>
</tr>
</tbody>
</table>

* = Standard deviation  L.S.D. = Least significant difference
* = Significant at 5% level.
The growth rate analysis at weekly intervals has revealed that in the $M_3$ generation, the seedling growth during the 1st week remained poor as in $M_1$ and $M_2$ generations. The growth rate showed a steady increase during the next two weeks and decreased in the 4th week uniformly in all cases and again showed an increase in the following weeks till it entered the flowering stage in the 8th week (Figure-13).

Variation percentage on growth performance of the $M_3$ generation has been depicted in Figure-14. It becomes obvious that the difference in the height of the plant remained closer to each other between the treated and untreated control indicating the effect of ionizing radiations as minimised in the 3rd generation and the progenies have recovered almost to the full extent.

The analysis of coefficient of variation based on shoot performance data collected at weekly intervals shows that the induced variation in the treated progenies disappeared in the 3rd generation to give stability to the plants (Table-24). In a number of cases particularly of lower doses, the CV value has become lower to that of control, while in others the difference in CV value between the treated and untreated control has also been noted to be quite low giving support to the contention that the treated progenies have recovered themselves from the damaging effect of ionizing radiations in the 3rd generation.
Table - 24  Coefficient of variation for shoot length of 
M₃ generation of *L. usitatissimum* L. var. 
Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td>21.60</td>
</tr>
<tr>
<td>25</td>
<td>17.37</td>
</tr>
<tr>
<td>50</td>
<td>14.11</td>
</tr>
<tr>
<td>75</td>
<td>12.04</td>
</tr>
<tr>
<td>100</td>
<td>20.06</td>
</tr>
<tr>
<td>125</td>
<td>22.94</td>
</tr>
<tr>
<td>150</td>
<td>18.32</td>
</tr>
</tbody>
</table>
Figure-13 indicates the rate of shoot growth in all the three generations till the plants entered the flowering stage (Plate-I). Under 25 krad treatment (13A) the $M_1$ generation experienced a short decline instead of growth on the 4th week and reached its peak in 7th week. The $M_2$ and $M_3$ generation behaved more or less in similar manner with the difference of 3rd generation having peak growth in the 6th week. Under 50 krad treatment the $M_1$ plants attain their peak on the 8th week (Figure-13B), while $M_2$ and $M_3$ plants had their growth peak in 7th week. The other treatments also showed a similar trend (Figure-13C,E,F) regarding the peak growth attainment as described under 50 krad treatment except 100 krad treatment in which all the three generations attained a peak in the 7th week (Figure-13D).
CONTROL
•o M₁ GENERATION
• M₂ GENERATION
○ M₃ GENERATION

FIG. 13
FIG. 14
Branching

M$_1$ generation: The time of branching and number of branches arising in the different individuals were noted at weekly intervals in the present study. The branching was noted to occur in 2nd week after sowing, in control as well as in 25, 50 and 75 krad treatments. In 3rd week, in addition to the above, the progenies of 100 and 125 krad treatments showed branching. It was in the 5th week, branching was noted to occur in 150 krad treatment. In control and 25 krad treatment, branching ceased by 6th week while in the other treatments it continued upto 8th week (Table-25).

The mean number of branches per plant in the treated individuals remained always low compared to control, at all stages of growth, excepting in a single case of 25 krad treatment in which the number of branches developed by 3rd and 4th week showed no significant difference with that of control (Table-25).

The per cent variation of this parameter showed a higher degree of variation in the treated progenies compared to control. Figure-15 depicts the per cent variation in the treated progenies at harvesting stage. The variation percentage happens to be high at higher doses as compared to that of lower ones.
Table - 25  Number of branch in $M_1$ generation of *L. usitatissimum* L. var. Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±0.714</td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±0.860</td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±0.492</td>
</tr>
<tr>
<td>75</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±0.017</td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±0.471</td>
</tr>
<tr>
<td>125</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±0.133</td>
</tr>
<tr>
<td>150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±0.612</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td></td>
</tr>
</tbody>
</table>

$\dagger$ = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
Table - 26 Coefficient of variation for branch number of $M_1$ generation of *L. usitatissimum* L. var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>75</td>
<td>-</td>
</tr>
<tr>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>125</td>
<td>-</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
</tr>
</tbody>
</table>
The analysis of coefficient of variation also revealed quite a high degree of variation within the treated populations, the maximum reaching 98.66 per cent in the 7th week in 150 krad treatment. In the 7th week 100 and 125 krad treatments also showed peak values of CV (Table-26).

M$_2$ generation: Table-27 shows the branching in M$_2$ generation. In the 2nd week all the progenies, including control, have been noted to bear branches almost in equal number. In the 3rd week 75 and 150 krad treatments produced significantly less number of branches compared to that of control, but in the 4th week, all the treated progenies have been noted to bear less number of branches than that of control. Similarly in 5th and 6th weeks also the number of branches differed significantly in the treated progenies compared to control but not in the case of 25 krad treatment. By 7th week the plants developed their maximum number of branches and therefore no further branches were noted in the 8th week. At the final stage, only 50, 75 and 125 krad treatments lagged behind in the number of branches compared to control to a significant level, while others produced almost equal number of branches to that of control. Figure-15 shows the per cent variation in the number of branches in the different progenies compared to control at harvesting stage.
Table - 27

Number of branch in M₂ generation of L. usitatissimum L. var. Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.80</td>
</tr>
<tr>
<td></td>
<td>±0.60</td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>±0.412</td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.60</td>
</tr>
<tr>
<td></td>
<td>±0.80</td>
</tr>
<tr>
<td>75</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>±0.806</td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.65</td>
</tr>
<tr>
<td></td>
<td>±0.653</td>
</tr>
<tr>
<td>125</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>±0.60</td>
</tr>
<tr>
<td>150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>±0.60</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.390</td>
</tr>
</tbody>
</table>

± = Standard deviation  L.S.D. = Least significant difference  * = Significant at 5% level.
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>33.33 20.71 19.3 35.25 30.69 27.76 28.56</td>
</tr>
<tr>
<td>25</td>
<td>19.65 20.71 33.68 57.61 27.60 36.0 40.32</td>
</tr>
<tr>
<td>50</td>
<td>50.0 22.10 27.27 24.0 35.6 33.33 35.93</td>
</tr>
<tr>
<td>75</td>
<td>53.73 19.29 33.33 46.77 26.71 32.51 34.38</td>
</tr>
<tr>
<td>100</td>
<td>39.57 38.56 47.31 33.67 35.68 33.18 40.92</td>
</tr>
<tr>
<td>125</td>
<td>33.33 22.89 27.27 52.50 40.08 31.90 33.12</td>
</tr>
<tr>
<td>150</td>
<td>33.33 25.72 33.95 68.95 61.06 36.35 38.63</td>
</tr>
</tbody>
</table>
Table-28 gives that the value of coefficient of variation in the different treated progenies of 2nd generation. The maximum variation has been recorded in case of 150 krad treatment in 5th week.

\[ M_3 \text{ generation:} \]
The number of branches per plant recorded for the 3rd generation showed that the branching starts in the 2nd week after sowing as in the case of other generations. A significantly low number of branches has been recorded in case of 25 krad, 100 krad and 150 krad treatments, compared to control. In the 3rd to 7th week all the treated individuals showed significantly less number of branches compared to control and thereafter no branching occurred (Table-29).

Figure-15 illustrates the per cent variation. The highest per cent variation has been recorded in 150 krad treatment followed by 75 and 25 krad. Table-30 gives the value of CV for the different treated progenies as well as of the control. Variation appears to be in narrow range in 3rd generation indicating that the radiation induced variation has almost disappeared in the 3rd generation.

When the number of branches per plant of all the three generations were compared at the time of harvesting it was noted that there is some residual effect of ionizing radiation in the subsequent generations of the treated progenies, particularly of higher doses, in which the bad effect has been noted to occur even in the 3rd generation.
Table - 29  Number of branches in M3 generation of L. usitatissimum L. var. Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>75</td>
<td>-</td>
</tr>
<tr>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>125</td>
<td>-</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>-</td>
</tr>
</tbody>
</table>

± = Standard deviation  
* = Significant at 5% level
Table - 30  Coefficient of variation for branch number of $M_3$ generation of *L. usitatissimum* L. var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Control - 20.12 32.73 29.86 38.25 25.73 31.66 28.27
25 - 30.30 33.33 41.64 51.22 43.22 40.26 44.46
75 - 33.33 22.89 24.17 32.81 28.98 33.67 36.90
100 - 23.16 22.89 32.71 36.84 27.78 38.16 41.08
125 - 28.56 42.20 30.65 27.64 42.45 32.24 36.24
150 - 18.56 30.31 28.93 33.51 32.64 29.85 37.84
FIG. 15

PER CENT VARIATION IN NUMBER OF BRANCHES

DOSES IN KRAD

- M₁ GENERATION
- M₂ GENERATION
- M₃ GENERATION
Length of Branch:

M1 generation: The growth of lateral shoot has been studied at weekly intervals starting from 2nd week till harvest. It has been found that the amount of lateral shoot elongation differs under different treatments from that of control to a significant level, except in a few cases in which no significant difference has been found to occur compared to the control (Table-31). In the progeny of 25 krad treatment, the lateral shoot length has been found not to differ to a significant level from the control at all stages of growth except the 4th week stage. The progeny of 50 krad treatment showed insignificant difference with the control just before and after flowering stages. While the 75 krad treatment showed insignificant difference in the lateral shoot height with that of control at the 8th week stage just before flowering (Table-31).

Figure-16 indicates the rate of lateral shoot elongation at weekly intervals during the vegetative phase of the progenies. The rate of lateral shoot elongation in control remained superior over the treated ones in all cases with the exception of 25 krad treatment in which rate of lateral shoot elongation exceeded that of control in 5th, 6th and 7th week stages.

Figure-17 gives the per cent variation under different treatments compared to control. Here the 25 krad treatment showed
Table - 31 Length of branch (cm) in M$_1$ generation of L. usitatissimum L. var Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Branch length in cm. Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control 0.0</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>±0.110</td>
</tr>
<tr>
<td>25</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>±0.206</td>
</tr>
<tr>
<td>50</td>
<td>0.35*</td>
</tr>
<tr>
<td></td>
<td>±0.140</td>
</tr>
<tr>
<td>75</td>
<td>0.25*</td>
</tr>
<tr>
<td></td>
<td>±0.107</td>
</tr>
<tr>
<td>100</td>
<td>0.81*</td>
</tr>
<tr>
<td></td>
<td>±0.688</td>
</tr>
<tr>
<td>125</td>
<td>0.68*</td>
</tr>
<tr>
<td></td>
<td>±0.355</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.4516</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference

* = Significant at 5% level.
Table - 32  Coefficient of variation for branch length of *L. usitatissimum* L. var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>75</td>
<td>-</td>
</tr>
<tr>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>125</td>
<td>-</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
</tr>
</tbody>
</table>
the least variation in lateral shoot elongation. Under the other treatments, per cent variation showed a high value as the intensity of doses increased. The analysis of coefficient of variation regarding the lateral shoot growth has revealed that the CV value shows a higher percentage under high intensity doses at all stages of growth. Under high intensity doses like 100, 125, and 150 krad treatments, the recorded CV value has gone upto 86, 70 and 73 percent respectively. At the final stage also, a high value of CV has been recorded under high intensity doses (Table-32), indicating that in M₁ generation the amount of variation is quite high in the treated progenies compared to control.

M₂ generation:- A similar comparison of lateral shoot growth in M₂ generation has shown that there is no significant difference, in the amount of growth of lateral branches at their initial stage except in one case (100 krad treatment). 25 krad treatment did not show any variation in the rate of elongation of lateral branches at all stages of observation including the final harvest stage. 50 krad treatment showed significantly less amount of elongation of lateral branch in the 3rd, 5th, 6th and 7th week stage, while 75 krad treatment at the 3rd, 4th, 6th and 7th week stage, 100 krad treatment throughout the vegetative phase. However the progeny of 100 krad treatment gets recovered from the
effect of ionizing radiation during the reproductive phase and the rate comes to the level of control. 125 krad treatment on the other hand, produced significantly less amount of lateral shoot growth throughout the vegetative phase excepting the 2nd and 4th week stages, but not during the reproductive phase. In case of 150 krad treatment, it has been found that the $M_2$ generation of this treatment showed an overall improvement in lateral shoot growth except the 3rd and 6th week stages (Table-33).

Figure-16 shows the rate of weekly increment of shoot length in lateral branches in $M_2$ generation. At the initial stage, all the progenies followed more or less similar rate of lateral branch growth while in the 3rd to 6th week stage, the treated plants showed a slow rate compared to control. At the close of vegetative phase, the treated progenies showed a better rate of growth in lateral branch elongation compared to control, irrespective of the intensity of doses.

Figure-17 illustrates that the per cent variation of the different treated progenies compared to control. The per cent variation does not appear to be considerable at the harvesting stage, indicating the recovery of the 2nd generation from the radiation effect involved in the treatment. Table-34 gives the value of coefficient of variation of 2nd generation under different treatments. It becomes clear from the data that the variation is not wide between the treated and untreated control in
Table - 33  Length of branch (cm) in M2 generation of L. usitatissimum L. var Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Branch length in cm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weeks after germination</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>125</td>
<td>-</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>-</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
Table - 34  Coefficient of variation for length of branch in M<sub>2</sub> generation of *L. usitatissimum* L. var Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>25.41</td>
<td>33.96</td>
<td>24.34</td>
<td>17.85</td>
<td>38.57</td>
<td>24.72</td>
<td>20.01</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>-</td>
<td>35.46</td>
<td>39.93</td>
<td>35.46</td>
<td>29.87</td>
<td>22.47</td>
<td>21.49</td>
<td>22.50</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
<td>40.68</td>
<td>55.02</td>
<td>31.01</td>
<td>44.69</td>
<td>31.96</td>
<td>26.93</td>
<td>25.92</td>
</tr>
<tr>
<td>75</td>
<td>-</td>
<td>55.81</td>
<td>62.66</td>
<td>62.39</td>
<td>42.20</td>
<td>64.30</td>
<td>19.17</td>
<td>20.21</td>
</tr>
<tr>
<td>100</td>
<td>-</td>
<td>50.96</td>
<td>75.15</td>
<td>50.61</td>
<td>41.00</td>
<td>40.71</td>
<td>30.46</td>
<td>35.82</td>
</tr>
<tr>
<td>125</td>
<td>-</td>
<td>60.63</td>
<td>57.47</td>
<td>46.45</td>
<td>58.38</td>
<td>45.11</td>
<td>23.22</td>
<td>40.31</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
<td>60.51</td>
<td>59.64</td>
<td>51.94</td>
<td>72.18</td>
<td>59.42</td>
<td>39.06</td>
<td>60.06</td>
</tr>
</tbody>
</table>
the 2nd generation except in the high intensity of doses indicating the stability that the treated progenies are going to develop in the future generation.

Table-55 records the amount of shoot axis elongation in lateral branches of the 3rd generation at successive stages of growth. It becomes obvious that the amount of growth achieved by the lateral branches is almost equal under all treatments, without any significant level of difference throughout the life of the plant except at their very initial stage. Figure-16 shows the rate of lateral branch growth in the 3rd generation and Figure-17 illustrates the per cent variation under different treatments.

Table-36 gives the value of coefficient of variation in the different treated progenies of the 3rd generation. The data indicate that the 3rd generation had almost fully recovered from the damaging effect of radiation and stabilized themselves to the level of control.

Figure-16 gives a comparative picture of the growth behaviour of lateral branches at different intervals in the different generations. While M_1 generation of the treated progenies showing retarded growth rate, the M_2 and M_3 generations showed an
Table - 35 Length of branch (cm) in M₂ generation of L. usitatissimum L. var. Mukta under different gamma-ray doses at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Branch length in cm</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>±0.225±1.333</td>
<td>±1.008±1.722</td>
</tr>
<tr>
<td>25</td>
<td>1.3*</td>
<td>±1.998±1.948</td>
</tr>
<tr>
<td>50</td>
<td>1.65*</td>
<td>±1.097±2.791</td>
</tr>
<tr>
<td>75</td>
<td>1.8*</td>
<td>±1.157±2.676</td>
</tr>
<tr>
<td>100</td>
<td>1.05*</td>
<td>±1.689±2.008</td>
</tr>
<tr>
<td>125</td>
<td>1.05*</td>
<td>±2.441±2.700</td>
</tr>
<tr>
<td>150</td>
<td>1.12*</td>
<td>±2.05±2.215</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.1956</td>
<td>±2.0125±2.1832</td>
</tr>
</tbody>
</table>

* = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
Table - 36  Coefficient of variation for length of branch of \( M_3 \) generation of \( L. \) usitatissimum \( L. \) var. Mukta under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-</td>
<td>11.25</td>
<td>32.43</td>
<td>17.71</td>
<td>19.93</td>
<td>30.93</td>
<td>26.44</td>
<td>24.82</td>
</tr>
<tr>
<td>25</td>
<td>-</td>
<td>19.30</td>
<td>74.83</td>
<td>31.89</td>
<td>36.24</td>
<td>36.84</td>
<td>29.73</td>
<td>31.86</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
<td>15.45</td>
<td>17.66</td>
<td>35.95</td>
<td>27.36</td>
<td>35.96</td>
<td>43.54</td>
<td>35.32</td>
</tr>
<tr>
<td>75</td>
<td>-</td>
<td>6.94</td>
<td>37.47</td>
<td>35.63</td>
<td>26.99</td>
<td>28.68</td>
<td>35.80</td>
<td>31.21</td>
</tr>
<tr>
<td>100</td>
<td>-</td>
<td>2.38</td>
<td>62.32</td>
<td>42.18</td>
<td>45.18</td>
<td>34.20</td>
<td>32.31</td>
<td>30.01</td>
</tr>
<tr>
<td>125</td>
<td>-</td>
<td>1.04</td>
<td>72.43</td>
<td>52.13</td>
<td>60.22</td>
<td>60.19</td>
<td>45.95</td>
<td>40.05</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
<td>2.23</td>
<td>47.12</td>
<td>36.10</td>
<td>50.93</td>
<td>35.85</td>
<td>31.57</td>
<td>32.98</td>
</tr>
</tbody>
</table>
enhanced rate of growth under all treatments. Further the $M_2$ and $M_3$ generation attain the peak growth earlier than the $M_1$ generation.

The treated progenies in general showed a lesser amount of shoot growth in $M_1$ generation than in the $M_2$ and $M_3$ generations except the 25 krad treatment. The progenies of 50 and 150 krad treatment showed a higher amount of shoot growth in $M_2$ generation than the others. The $M_3$ generation also showed a better growth than the $M_1$ generation. Here also 25 krad treatment finds its exception.
Figure 10

WEEKS AFTER GERMINATION

FIG. 16
FIG. 17

- **M₁ GENERATION**
- **M₂ GENERATION**
- **M₃ GENERATION**

**DOSES IN KRAD**

**PER CENT VARIATION IN BRANCH LENGTH**

<table>
<thead>
<tr>
<th>Dose (Krad)</th>
<th>M₁</th>
<th>M₂</th>
<th>M₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Leaf formation:—

Leaf formation has been taken as a parameter to study the effect of ionizing radiations in the form of gamma-rays in different doses. The formation of leaf has been studied under two heads viz. main shoot and lateral shoots.

$M_1$ generation: Leaf formation has been recorded at weekly intervals both in control and treated progenies by counting the number of leaves produced in a week's duration. Table-37 gives the number of leaves borne on the main shoot at successive stages of growth. It is clear from the Table-37 that the number of leaves produced by the treated plants are less compared to control in the one week old seedlings with the exception of 25 krad treatment. In two week old seedlings, all the treated progenies showed significantly lesser number of leaves than control. In the subsequent stages also, the same trend in leaf number has been noticed in all cases except in 25 krad treatment.

The recorded observations of leaf number on lateral branches also showed that the treated progenies produced significantly less number of leaves compared to control with the exception of 25 krad treatment in which the readings taken on 2nd and 4th week indicated that the leaf number are less only in these two stages and not in others (Table-38). Figures 18 and 19 show the
Table - 37  Number of leaves on the main shoot axis of M1 generation under different gamma-ray treatments at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in krad</th>
<th>Leave of main shoot axis</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Control</td>
<td>2.4</td>
<td>13.95</td>
</tr>
<tr>
<td></td>
<td>±1.732</td>
<td>±1.856</td>
</tr>
<tr>
<td>25</td>
<td>3.1</td>
<td>12.15*</td>
</tr>
<tr>
<td></td>
<td>±1.428</td>
<td>±0.963</td>
</tr>
<tr>
<td>50</td>
<td>0.9*</td>
<td>9.9*</td>
</tr>
<tr>
<td>75</td>
<td>0.3*</td>
<td>7.0*</td>
</tr>
<tr>
<td>100</td>
<td>0.5*</td>
<td>6.5*</td>
</tr>
<tr>
<td></td>
<td>±0.466</td>
<td>±2.0.*</td>
</tr>
<tr>
<td>125</td>
<td>0.0</td>
<td>4.15*</td>
</tr>
<tr>
<td></td>
<td>±1.525</td>
<td>±2.310</td>
</tr>
<tr>
<td>150</td>
<td>0.0</td>
<td>4.1*</td>
</tr>
<tr>
<td></td>
<td>±0.278</td>
<td>±4.077</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.6470</td>
<td>1.4825</td>
</tr>
</tbody>
</table>

± = Standard deviation  L.S.D. = Least significant difference
* = Significant at 5% level.
Table - 38  Number of leaves per lateral branch of M₁ generation under different gamma-ray treatments at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Leaves of branch</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Control</td>
<td>3.94</td>
<td>11.41</td>
</tr>
<tr>
<td></td>
<td>±1.901</td>
<td>±4.488</td>
</tr>
<tr>
<td>25</td>
<td>2.32*</td>
<td>10.38</td>
</tr>
<tr>
<td></td>
<td>±1.274</td>
<td>±2.69</td>
</tr>
<tr>
<td>50</td>
<td>1.53*</td>
<td>6.60*</td>
</tr>
<tr>
<td></td>
<td>±0.925</td>
<td>±2.027</td>
</tr>
<tr>
<td>75</td>
<td>1.00*</td>
<td>5.27*</td>
</tr>
<tr>
<td></td>
<td>±0.447</td>
<td>±1.951</td>
</tr>
<tr>
<td>100</td>
<td>-</td>
<td>4.31*</td>
</tr>
<tr>
<td></td>
<td>±2.922</td>
<td>±3.11</td>
</tr>
<tr>
<td>125</td>
<td>-</td>
<td>2.85*</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>±2.28</td>
<td>±6.278</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.8136</td>
<td>1.4369</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
rate of leaf production in the main shoot and lateral shoots respectively. In both the cases the rate of leaf production happens to be higher in control than in the treated progenies. There is gradual fall in the number of leaves per plant with the increasing intensity of gamma-rays involved in the treatments. This trend is uniformly maintained both in the main as well as in lateral shoots with occasional minor departure on either side.

Figure 20 and 21 illustrate the per cent variation in leaf number in the treated progenies in relation to main shoot and lateral shoots respectively. The treated progenies differed in leaf number to a greater extent compared to control depending on the intensity of gamma-ray doses experienced by the progenies. The trend of variation happens to be the same both in the main (Figure-20) and lateral shoots (Figure-21).

Table-39 gives the value of coefficient of variation in the different treated progenies at different intervals. It becomes obvious, as in the other parameters studied, the CV value happens to be higher in the treated progenies compared to control but the degree of variation being much narrow than in the other parameters described so far. Table-40 gives the value of coefficient of variation regarding leaf number of the lateral shoots. Here also the treated progenies showed higher value than the control but the degree of variation has been found to be much higher than what it has been noted for the main shoot.
Table - 39  Coefficient of variation for number of leaves on main shoot of M₁ generation under different gamma-ray treatment.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>42.16</td>
<td>13.30</td>
<td>13.86</td>
<td>15.50</td>
<td>16.67</td>
<td>10.80</td>
<td>9.61</td>
<td>9.61</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>46.06</td>
<td>7.92</td>
<td>19.04</td>
<td>12.35</td>
<td>19.84</td>
<td>14.03</td>
<td>9.98</td>
<td>9.98</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>43.77</td>
<td>15.28</td>
<td>14.85</td>
<td>25.39</td>
<td>12.33</td>
<td>16.85</td>
<td>14.50</td>
<td>9.06</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>43.77</td>
<td>15.28</td>
<td>14.85</td>
<td>25.39</td>
<td>12.33</td>
<td>16.85</td>
<td>14.50</td>
<td>9.06</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>71.36</td>
<td>28.57</td>
<td>21.00</td>
<td>19.16</td>
<td>20.34</td>
<td>13.96</td>
<td>16.91</td>
<td>13.11</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>89.2</td>
<td>30.76</td>
<td>17.42</td>
<td>21.40</td>
<td>15.77</td>
<td>19.38</td>
<td>17.66</td>
<td>13.98</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>-</td>
<td>54.07</td>
<td>48.82</td>
<td>24.18</td>
<td>24.22</td>
<td>17.17</td>
<td>16.66</td>
<td>20.75</td>
</tr>
<tr>
<td>Doses in Krad</td>
<td>Weeks after germination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
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</tr>
<tr>
<td>25</td>
<td></td>
<td>54.91</td>
<td>25.97</td>
<td>37.97</td>
<td>34.52</td>
<td>44.86</td>
<td>47.29</td>
<td>47.29</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>60.14</td>
<td>30.06</td>
<td>48.28</td>
<td>51.54</td>
<td>46.10</td>
<td>44.82</td>
<td>45.59</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>44.70</td>
<td>37.02</td>
<td>64.59</td>
<td>50.30</td>
<td>70.02</td>
<td>40.00</td>
<td>66.47</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>67.74</td>
<td>44.68</td>
<td>50.13</td>
<td>52.29</td>
<td>46.00</td>
<td>59.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>41.54</td>
<td>52.79</td>
<td>34.63</td>
<td>55.19</td>
<td>55.42</td>
<td>48.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>33.52</td>
<td>55.69</td>
<td>55.21</td>
<td>56.37</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
M₂ generation: The number of leaves has also been recorded for 2nd generation at weekly intervals both in the main as well as in lateral shoots. Table-41 summarises the readings taken on leaf number on the main shoot in the M₂ generation. Here it is noted that the treated progenies produced significantly less number of leaves compared to control with the exception of 25 krad treatment and a few others at the last stage of the growth performance. Under 100 krad treatment, the initial as well as the last stage has shown almost equal number of leaves to that of control where as in 125 and 150 krad treatments, the last stage readings showed no significant difference in leaf number per plant compared to control.

The leaf count of M₂ generation on lateral branches had shown that in 2 week old seedlings the progenies of 75, 100 and 125 krad treatments showed significantly less number of leaves to that of control. In 3 week old seedlings, a similar count has revealed that all the treated progenies produced less number of leaves compared to control with the exception of 25 krad treatment. In 4 week old seedlings no difference has been noticed in leaf number in all the treated progenies, irrespective of dose intensity compared to control. In 5 week old plants the same trend in leaf number has been noticed with the exception of 100 krad treatment. In 6 week old stage the progenies of 50, 75 and
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Leaves of main shoot axis</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Control</td>
<td>4.80 ± 1.326</td>
<td>16.90 ± 2.487</td>
</tr>
<tr>
<td>25</td>
<td>4.30 ± 1.705</td>
<td>17.15 ± 2.174</td>
</tr>
<tr>
<td>50</td>
<td>3.7* ± 1.705</td>
<td>13.70* ± 2.776</td>
</tr>
<tr>
<td>75</td>
<td>3.8* ± 1.240</td>
<td>13.80* ± 1.777</td>
</tr>
<tr>
<td>100</td>
<td>4.20 ± 1.077</td>
<td>14.40* ± 1.959</td>
</tr>
<tr>
<td>125</td>
<td>3.60* ± 1.356</td>
<td>14.00* ± 2.828</td>
</tr>
<tr>
<td>150</td>
<td>3.90 ± 1.33</td>
<td>14.7 ± 2.027</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.9169</td>
<td>1.5045</td>
</tr>
</tbody>
</table>

+ = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Leaves of branch</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>±2.34</td>
<td>5.50</td>
</tr>
<tr>
<td>25</td>
<td>±1.97</td>
<td>6.00</td>
</tr>
<tr>
<td>50</td>
<td>±2.44</td>
<td>4.75</td>
</tr>
<tr>
<td>75</td>
<td>±1.77</td>
<td>3.83*</td>
</tr>
<tr>
<td>100</td>
<td>±1.35</td>
<td>2.72*</td>
</tr>
<tr>
<td>125</td>
<td>±2.25</td>
<td>4.17*</td>
</tr>
<tr>
<td>150</td>
<td>±2.11</td>
<td>4.66</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>±1.3085</td>
<td>2.4621</td>
</tr>
</tbody>
</table>

+= Standard deviation
* = Significant at 5% level.
L.S.D. = Least Significant difference
and 100 krad treatments produced significantly less number of leaves than in the others. In 7th week, the leaf count has shown that only 50 krad, 100 krad, and 125 krad treatments produced lesser number of leaves per branch compared to others (Table-42).

Figure-20 and 21 gives the per cent variation in leaf number on the main shoot and in the lateral branches respectively. Values given in the tables indicates that the degree of difference is not wide in M₂ generation indicating the induced variation in leaf production is getting stabilized in the 2nd generation.

Table-43 gives the values of CV for the leaf number on the main shoot in the different treated progeny of the M₂ generation. The degree of variation in the different progenies indicates no further departure of the treated progenies than that of control.

Table-44 indicates the CV value of the different treated progenies regarding leaf number on lateral branch in the 2nd generation during their successive stages of the growth. Here also the variation has been narrowed in the majority of cases to, however, around the one of control.
Table 43  Coefficient of variation for number of leaves on main shoot of M₂ generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td>27.62</td>
</tr>
<tr>
<td>50</td>
<td>46.10</td>
</tr>
<tr>
<td>75</td>
<td>32.63</td>
</tr>
<tr>
<td>100</td>
<td>25.64</td>
</tr>
<tr>
<td>125</td>
<td>37.66</td>
</tr>
<tr>
<td>150</td>
<td>34.10</td>
</tr>
<tr>
<td>Doses in Krad</td>
<td>Weeks after germination</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>75</td>
<td>-</td>
</tr>
<tr>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>125</td>
<td>-</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
</tr>
</tbody>
</table>
**M₃ generation:-** As in the first two generations, the leaf count was also made in the 3rd generation at weekly intervals both in the main shoot and in the lateral ones. Table-45 summarises the results obtained in this connection. In one week old seedling, the leaf count has revealed that all the treated progenies produced significantly less number of leaves than in control. In the 2nd stage 75, 100 and 125 krad treatments showed significantly less number of leaves in the main shoot than the control plants. In 4th and 7th week the number of leaves in all the treated progenies were significantly lesser than in control except the 50 krad treatment in which in the 4th week the number of leaves differed significantly from that of control, while in the other stages no significant difference has been noted in this progeny. In the last stage, the leaf number differed to a significant level only in 100 krad treatment.

Table-46 gives the leaf number per lateral branch in the different treated progenies of M₃ generation. In two week old seedling, the progeny of 25 krad, 100, 125 and 150 krad treatments showed lesser number of leaves per branch but in the 3 week old seedlings only 50 and 75 krad treatments showed poor number of leaves compared to that of control. In the other stages 75, 100 and 150 krad treatments showed significantly less number of leaves per branch. Figure 18 and 19 illustrate the rate of leaf
Table - 45  Number of leaves on the main shoot axis of M₃ generation under different gamma-ray treatments at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Leaves of main shoot axis</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>5.4</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>4.05*</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>3.7*</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>3.9*</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>3.7*</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>2.5*</td>
</tr>
<tr>
<td>L.S.D. at 5%</td>
<td></td>
<td>0.8682</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
### Table - 46

Number of leaves per lateral branch of M₂ generation under different gamma-ray treatments at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Leaves of lateral branch</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>5.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.663</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>3.84*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.689</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>5.09</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>4.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.532</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>3.71*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.856</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>2.57*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.925</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>3.71</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td></td>
<td>0.9468</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
production in the different treated progenies of the 3rd generation at weekly intervals both in their main shoot and in the lateral branches respectively.

Figure 20 and 21 give the value of per cent variation in the main shoot and lateral branches respectively. Both in the main shoot and in lateral branches the leaf number did not differ to any great extent as in the 2nd generation. The difference being narrow, one likely to take the induced-variation due to gamma-ray treatment has in its verge of vanishment in the 3rd generation.

Table-47 gives the CV value regarding leaf number per plant in the main shoot of the 3rd generation. Although the treated progenies showed a little higher value than the control, particularly in the initial stages of growth and under high intensity doses, the variation gets reduced with the time as the plants grow old. In some cases the CV value has been found to be lower than the control itself at the last stage.

Table-48 gives the CV value regarding the leaf number per lateral branch. Here both in the control as well as the treated progenies, the values go high showing the inconsistent behaviour of this trait as an inherent quality in the selected variety.
Table - 47  Coefficient of variation for number of leaves on main shoot of \( M_3 \) generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>26.44</td>
<td>15.49</td>
<td>16.43</td>
<td>15.78</td>
<td>19.23</td>
<td>15.15</td>
<td>15.83</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>44.07</td>
<td>13.96</td>
<td>16.04</td>
<td>13.75</td>
<td>15.68</td>
<td>8.84</td>
<td>8.84</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>30.93</td>
<td>15.95</td>
<td>13.01</td>
<td>20.31</td>
<td>22.60</td>
<td>11.62</td>
<td>7.86</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>25.48</td>
<td>14.99</td>
<td>17.47</td>
<td>13.50</td>
<td>19.62</td>
<td>11.84</td>
<td>7.38</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>30.91</td>
<td>14.64</td>
<td>19.00</td>
<td>18.72</td>
<td>24.09</td>
<td>15.54</td>
<td>20.33</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>39.43</td>
<td>14.84</td>
<td>16.22</td>
<td>18.51</td>
<td>24.86</td>
<td>14.54</td>
<td>14.00</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>60.92</td>
<td>17.59</td>
<td>12.66</td>
<td>19.11</td>
<td>31.63</td>
<td>17.38</td>
<td>14.43</td>
</tr>
</tbody>
</table>
Table - 48  Coefficient of variation for number of leaves for lateral branch of $M_3$ generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>75</td>
<td>-</td>
</tr>
<tr>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>125</td>
<td>-</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
</tr>
</tbody>
</table>
FIG. 18

Rate of leaf production on main shoot weeks after germination for various doses of irradiation:

- **A**: 25 Krad
- **B**: 50 Krad
- **C**: 75 Krad
- **D**: 100 Krad
- **E**: 125 Krad
- **F**: 150 Krad

Legend:
- CONTROL
- \( M_1 \) GENERATION
- \( M_2 \) GENERATION
- \( M_3 \) GENERATION
Fig. 19

- 25 KRAD
- 50 KRAD
- 75 KRAD
- 100 KRAD
- 125 KRAD
- 150 KRAD

WEEKS AFTER GERMINATION

CONTROL
- M1 GENERATION
- M2 GENERATION
- M3 GENERATION
Figure 20: Per cent variation in leaf production on main shoot across different doses in krads for M1, M2, and M3 generations.
FIG. 21

PER CENT VARIATION IN LEAF PRODUCTION ON LATERAL BRANCH

DOSES IN KRAD

M₁ GENERATION
M₂ GENERATION
M₃ GENERATION
Leaf area:

M₁ generation: The average leaf area under different regions of the plant viz., basal, middle and upper varied in size to a significant extent (Table-49). It becomes clear from the data that under all the treatments, the leaf area differs at different regions within a plant as well as in the different plants raised under different treatments. In the basal region, the leaf area was found to be significantly less under 75, 100, 125 and 150 krad treatments compared to control. Similarly the middle and upper regions also displayed significantly less leaf area compared to control. Figure-22 shows the per cent variation regarding leaf area over the control. In no case the treated progenies showed a higher area per leaf over that of control in M₁ generation. Uniformly, under all treatments, the leaf size showed a reduction which is being higher under high intensity doses than in lower ones.

Table-50 gives the CV value regarding leaf size under different treatments in M₁ generation based on the average size of leaf per plant. The leaf area has been calculated in the treated progenies at their successive stages of growth. Table-51 summarises the results obtained in this regard. A glance at the results indicates that the leaf area per plant differs significantly under all treatments and all the stages of growth compared to
Table - 49  Leaf size (cm²) in M₁ generation of *L. usitatissimum* L. var. Mukta under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Leaf size in cm²</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basal</td>
<td>Middle</td>
<td>Upper</td>
<td>Mean</td>
</tr>
<tr>
<td>Control</td>
<td>0.397 ±0.1195</td>
<td>1.450 ±0.4062</td>
<td>1.442 ±0.6210</td>
<td>1.096 ±0.3822</td>
</tr>
<tr>
<td>25</td>
<td>0.338 ±0.1479</td>
<td>1.090* ±0.2131</td>
<td>1.118* ±0.4827</td>
<td>0.848* ±0.2812</td>
</tr>
<tr>
<td>50</td>
<td>0.381 ±0.1504</td>
<td>1.108* ±0.4122</td>
<td>0.992* ±0.3384</td>
<td>0.827* ±0.3003</td>
</tr>
<tr>
<td>75</td>
<td>0.178* ±0.0797</td>
<td>0.827* ±0.3707</td>
<td>1.031* ±0.5066</td>
<td>0.679* ±0.3190</td>
</tr>
<tr>
<td>100</td>
<td>0.183* ±0.0860</td>
<td>0.590* ±0.3345</td>
<td>0.735* ±0.3929</td>
<td>0.502* ±0.2711</td>
</tr>
<tr>
<td>125</td>
<td>0.25* ±0.0609</td>
<td>0.670* ±0.1643</td>
<td>0.660* ±0.3830</td>
<td>0.527* ±0.0536</td>
</tr>
<tr>
<td>150</td>
<td>0.131* ±0.0278</td>
<td>0.358* ±0.0886</td>
<td>0.248* ±0.0445</td>
<td>0.246* ±0.0536</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.0783</td>
<td>0.2015</td>
<td>0.2864</td>
<td>0.1887</td>
</tr>
</tbody>
</table>

† = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
Table - 50  Coefficient of variation for leaf size of $M_1$
generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Leaf Size</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basal</td>
<td>Middle</td>
<td>Upper</td>
<td>Mean</td>
</tr>
<tr>
<td>Control</td>
<td>30.10</td>
<td>28.01</td>
<td>43.06</td>
<td>34.87</td>
</tr>
<tr>
<td>25</td>
<td>43.75</td>
<td>19.55</td>
<td>43.11</td>
<td>33.13</td>
</tr>
<tr>
<td>50</td>
<td>39.47</td>
<td>37.19</td>
<td>34.08</td>
<td>36.29</td>
</tr>
<tr>
<td>75</td>
<td>44.75</td>
<td>44.81</td>
<td>49.09</td>
<td>46.98</td>
</tr>
<tr>
<td>100</td>
<td>46.86</td>
<td>56.69</td>
<td>53.33</td>
<td>58.89</td>
</tr>
<tr>
<td>125</td>
<td>24.36</td>
<td>24.40</td>
<td>57.96</td>
<td>38.45</td>
</tr>
<tr>
<td>150</td>
<td>21.09</td>
<td>24.74</td>
<td>17.89</td>
<td>21.77</td>
</tr>
<tr>
<td>Doses in Krad</td>
<td>Total leaf area in cm² per plant</td>
<td>L.S.D. at 5% level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>----------------------------------</td>
<td>-------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>0.2088 0.5066 1.6444 6.0494 11.0816 15.183 19.3678 22.7447 21.9958 20.351</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>±0.678 ±2.273 ±6.987 ±26.392 ±35.870 ±49.592 ±102.021 ±102.021 ±87.936 ±80.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>±0.598 ±1.463 ±4.385 ±14.271 ±29.988 ±47.638 ±43.631 ±43.631 ±48.616 ±44.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>±0.535 ±1.273 ±3.88 ±14.50 ±23.72 ±38.50 ±44.33 ±53.63 ±108.04 ±104.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>±0.150 ±0.371 ±1.401 ±5.328 ±10.75 ±13.995 ±12.773 ±21.142 ±23.537 ±22.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>±0.091 ±1.19 ±3.90 ±10.79 ±20.16 ±35.55 ±43.83 ±64.85 ±120.03 ±116.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>±0.025 ±1.03 ±3.4 ±9.09 ±17.40 ±28.24 ±31.91 ±38.85 ±72.95 ±69.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weeks after germination</th>
<th>Total leaf area (cm²) per plant</th>
<th>10th Week = Flowering stage 16th Week = Harvesting stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.19 ±0.678 ±2.273 ±6.987 ±26.392 ±35.870 ±49.592 ±102.021 ±102.021 ±87.936 ±80.95</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8.19 ±0.598 ±1.463 ±4.385 ±14.271 ±29.988 ±47.638 ±43.631 ±43.631 ±48.616 ±44.23</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>22.88 ±0.495 ±1.107 ±2.634 ±11.638 ±23.583 ±34.44 ±17.253 ±33.599 ±31.572 ±28.94</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>90.16 ±0.053 ±1.273 ±3.88 ±14.50 ±23.72 ±38.50 ±44.33 ±53.63 ±108.04 ±104.16</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>149.33 ±0.091 ±1.19 ±3.90 ±10.79 ±20.16 ±35.55 ±43.83 ±64.85 ±120.03 ±116.12</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>223.09 ±0.162 ±0.357 ±1.581 ±5.499 ±11.291 ±18.374 ±18.645 ±26.461 ±28.956 ±27.37</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>335.53 ±0.025 ±1.03 ±3.4 ±9.09 ±17.40 ±28.24 ±31.91 ±38.85 ±72.95 ±69.55</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>335.53 ±0.111 ±0.508 ±1.162 ±3.892 ±10.373 ±15.677 ±17.569 ±15.736 ±15.337 ±14.17</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>527.71 ±0.540 ±1.10 ±2.48 ±5.15 ±7.49 ±9.98 ±13.76 ±27.06 ±25.95 ±25.95</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>504.83 +0.227 ±0.607 ±1.227 ±2.327 ±3.994 ±4.388 ±6.367 ±5.753 ±5.15</td>
<td></td>
</tr>
</tbody>
</table>

± = Standard deviation  L.S.D. = Least significant difference  
* = Significant at 5% level.
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td>56.95</td>
</tr>
<tr>
<td>25</td>
<td>57.09</td>
</tr>
<tr>
<td>50</td>
<td>77.3</td>
</tr>
<tr>
<td>75</td>
<td>244.0</td>
</tr>
<tr>
<td>100</td>
<td>176.0</td>
</tr>
<tr>
<td>125</td>
<td>440.0</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
</tr>
</tbody>
</table>
that of control. The per cent variation in leaf area per plant over the control has been depicted in Figure-23. The reduction in leaf area per plant has been found as high as 90 per cent and more in several cases particularly under high intensity doses. The CV value calculated to know the variation within the population has shown that it is higher in the treated progenies than the control, illustrating the occurrence of induced variation in the treated progenies (Table-52).

**M₂ generation:** The leaf size in different regions of a plant as well as the leaf area per plant under different stages of its growth has been studied in M₂ generation as in the M₁. Table-53 gives the results obtained in regard to leaf size in the different regions of a plant under different treatments. It becomes clear from the data that the leaf size per plant under different treatments does not differ to any significant level (Figure-22).

Table-54 gives the CV value regarding leaf size in the second generation. It does not appear to vary much in this generation on this basis.

Table-55 summarises the results obtained in respect of leaf area per plant under different treatments at successive stages of growth of M₂ generation. The treated progenies showed reduced
Table - 53  Leaf size (cm$^2$) in $M_2$ generation of *L. usitatissimum* L. var. Mukta under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Basal</th>
<th>Middle</th>
<th>Upper</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.38 ±0.108</td>
<td>1.46 ±0.462</td>
<td>1.45 ±0.608</td>
<td>1.098 ±0.392</td>
</tr>
<tr>
<td>25</td>
<td>0.37 ±0.129</td>
<td>1.38 ±0.558</td>
<td>1.30 ±0.600</td>
<td>0.982 ±0.362</td>
</tr>
<tr>
<td>50</td>
<td>0.38 ±0.156</td>
<td>1.18 ±0.415</td>
<td>1.21 ±0.621</td>
<td>0.927 ±0.411</td>
</tr>
<tr>
<td>75</td>
<td>0.34 ±0.147</td>
<td>1.30 ±0.415</td>
<td>1.31 ±0.621</td>
<td>0.986 ±0.394</td>
</tr>
<tr>
<td>100</td>
<td>0.324 ±0.119</td>
<td>1.29 ±0.483</td>
<td>1.40 ±0.631</td>
<td>1.006 ±0.411</td>
</tr>
<tr>
<td>125</td>
<td>0.37 ±0.128</td>
<td>1.38 ±0.479</td>
<td>1.32 ±0.783</td>
<td>1.027 ±0.463</td>
</tr>
<tr>
<td>150</td>
<td>0.39 ±0.131</td>
<td>1.44 ±0.479</td>
<td>1.44 ±0.798</td>
<td>1.093 ±0.469</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.1054</td>
<td>0.3085</td>
<td>0.3429</td>
<td>0.2522</td>
</tr>
</tbody>
</table>
Table - 54  Coefficient of variation for leaf size of M$_2$ generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Leaf size</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basal</td>
<td>Middle</td>
<td>Upper</td>
<td>Mean</td>
</tr>
<tr>
<td>Control</td>
<td>28.08</td>
<td>31.65</td>
<td>41.93</td>
<td>35.77</td>
</tr>
<tr>
<td>25</td>
<td>34.23</td>
<td>27.97</td>
<td>45.81</td>
<td>36.64</td>
</tr>
<tr>
<td>50</td>
<td>41.21</td>
<td>35.31</td>
<td>37.66</td>
<td>37.13</td>
</tr>
<tr>
<td>75</td>
<td>42.27</td>
<td>31.89</td>
<td>47.43</td>
<td>40.06</td>
</tr>
<tr>
<td>100</td>
<td>36.88</td>
<td>37.78</td>
<td>45.08</td>
<td>40.85</td>
</tr>
<tr>
<td>125</td>
<td>34.10</td>
<td>34.48</td>
<td>59.27</td>
<td>45.08</td>
</tr>
<tr>
<td>150</td>
<td>33.13</td>
<td>33.26</td>
<td>55.27</td>
<td>42.90</td>
</tr>
<tr>
<td>Doses in Krad</td>
<td>Total leaf area in cm² per plant</td>
<td>Weeks after germination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------</td>
<td>------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Control</td>
<td>1.85 ± 0.454</td>
<td>10.30 ± 2.578</td>
<td>24.70 ± 5.095</td>
<td>103.84 ± 24.921</td>
</tr>
<tr>
<td>25</td>
<td>1.62 ± 0.676</td>
<td>10.90 ± 2.09</td>
<td>20.41 ± 4.592</td>
<td>83.64 ± 23.958</td>
</tr>
<tr>
<td>50</td>
<td>1.40 ± 0.568</td>
<td>16.60 ± 2.717</td>
<td>17.19 ± 2.983</td>
<td>52.57 ± 20.088</td>
</tr>
<tr>
<td>75</td>
<td>1.32 ± 0.511</td>
<td>6.64 ± 1.681</td>
<td>17.50 ± 4.344</td>
<td>55.98 ± 24.05</td>
</tr>
<tr>
<td>100</td>
<td>1.36 ± 0.379</td>
<td>6.22 ± 1.23</td>
<td>13.70 ± 3.979</td>
<td>54.59 ± 15.22</td>
</tr>
<tr>
<td>125</td>
<td>1.35 ± 0.440</td>
<td>8.01 ± 2.497</td>
<td>17.94 ± 5.217</td>
<td>64.01 ± 18.76</td>
</tr>
<tr>
<td>150</td>
<td>1.54 ± 0.515</td>
<td>9.15 ± 2.486</td>
<td>20.61 ± 5.895</td>
<td>82.45 ± 25.15</td>
</tr>
<tr>
<td>L.S.D. 0%</td>
<td>0.33</td>
<td>1.4298</td>
<td>2.9185</td>
<td>13.4921</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level  
10th Week = Flowering stage  
16th Week = Harvesting stage
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>41.62</td>
<td>19.16</td>
<td>22.5</td>
<td>28.64</td>
<td>39.74</td>
<td>46.59</td>
<td>28.54</td>
<td>17.60</td>
<td>17.32</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>40.27</td>
<td>33.56</td>
<td>17.96</td>
<td>38.20</td>
<td>24.92</td>
<td>24.57</td>
<td>22.48</td>
<td>12.86</td>
<td>12.39</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>38.68</td>
<td>25.28</td>
<td>25.26</td>
<td>31.27</td>
<td>25.04</td>
<td>38.28</td>
<td>27.02</td>
<td>15.18</td>
<td>14.42</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>27.85</td>
<td>19.79</td>
<td>29.04</td>
<td>27.88</td>
<td>26.75</td>
<td>37.84</td>
<td>24.35</td>
<td>17.14</td>
<td>16.52</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>32.5</td>
<td>31.17</td>
<td>29.07</td>
<td>29.31</td>
<td>48.13</td>
<td>45.04</td>
<td>31.31</td>
<td>18.80</td>
<td>18.13</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>33.33</td>
<td>27.14</td>
<td>28.59</td>
<td>30.51</td>
<td>56.20</td>
<td>56.14</td>
<td>34.20</td>
<td>21.15</td>
<td>20.70</td>
</tr>
</tbody>
</table>
leaf area per plant to the extent of statistical significance under different treatments over control, excepting in a few cases particularly under 25 and 150 krad treatment. In the former case in 1st and 2nd week old seedlings as well as in 6th and 7th week old plants the leaf area did not show any significant difference from that of control. Similarly under 150 krad treatment in the first two weeks as well as in the 7th week, the leaf area did not significantly differ from that of control. Figure-23 gives the per cent variation regarding leaf area reduction per plant of the $M_2$ generation. Table-56 gives the CV value on leaf area parameter in the 2nd generation. The CV values of 2nd generation show that the variation is getting minimised.

$M_3$ generation: The findings on size variation of leaf in different regions of the plant in $M_3$ generation has shown that it does not differ in its average from one treatment to another compared to the control. (Table-57). Figure-22 gives the per cent variation in leaf size of the different treatments in $M_3$ generation over that of control. Although there is a reduction in size of leaf in all the treated progenies compared to that of control, the variation percentage does not appear to be appreciable. Table-58 indicates the variation within the population regarding leaf size in the different treatments. Being the third generation,
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Leaf size in cm²</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basal</td>
<td>Middle</td>
<td>Upper</td>
<td>Mean</td>
</tr>
<tr>
<td>Control</td>
<td>0.391 ± 0.118</td>
<td>1.50 ± 0.473</td>
<td>1.47 ± 0.725</td>
<td>1.121 ± 0.439</td>
</tr>
<tr>
<td>25</td>
<td>0.38 ± 0.112</td>
<td>1.38 ± 0.453</td>
<td>1.40 ± 0.711</td>
<td>1.05 ± 0.416</td>
</tr>
<tr>
<td>50</td>
<td>0.38 ± 0.129</td>
<td>1.46 ± 0.453</td>
<td>1.32 ± 0.528</td>
<td>1.05 ± 0.370</td>
</tr>
<tr>
<td>75</td>
<td>0.34 ± 0.109</td>
<td>1.38 ± 0.446</td>
<td>1.39 ± 0.620</td>
<td>1.04 ± 0.392</td>
</tr>
<tr>
<td>100</td>
<td>0.35 ± 0.127</td>
<td>1.40 ± 0.463</td>
<td>1.42 ± 0.543</td>
<td>1.06 ± 0.378</td>
</tr>
<tr>
<td>125</td>
<td>0.37 ± 0.128</td>
<td>1.41 ± 0.441</td>
<td>1.44 ± 0.602</td>
<td>1.07 ± 0.390</td>
</tr>
<tr>
<td>150</td>
<td>0.38 ± 0.129</td>
<td>1.42 ± 0.439</td>
<td>1.41 ± 0.582</td>
<td>1.07 ± 0.383</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.0986</td>
<td>0.2816</td>
<td>0.3131</td>
<td>0.2311</td>
</tr>
</tbody>
</table>

† = Standard deviation  
L.S.D. = Least significant difference
Table - 58  Coefficient of variation for leaf size of $M_3$
generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Leaf size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basal</td>
</tr>
<tr>
<td>Control</td>
<td>30.28</td>
</tr>
<tr>
<td>25</td>
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<td>50</td>
<td>33.61</td>
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<tr>
<td>75</td>
<td>31.43</td>
</tr>
<tr>
<td>100</td>
<td>35.82</td>
</tr>
<tr>
<td>125</td>
<td>34.28</td>
</tr>
<tr>
<td>150</td>
<td>34.06</td>
</tr>
</tbody>
</table>
Table - 59  Total leaf area (cm²) per plant of M₂ generation under different gamma-ray treatments at successive stages of growth.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Total leaf area in cm² per plant</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>10</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>2.11</td>
<td>10.69</td>
<td>26.66</td>
<td>117.74</td>
<td>185.50</td>
<td>259.45</td>
<td>316.88</td>
<td>504.0</td>
<td>477.34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.560</td>
<td>±1.910</td>
<td>±10.53</td>
<td>±47.65</td>
<td>±62.081</td>
<td>±90.74</td>
<td>±132.10</td>
<td>±105.89</td>
<td>±95.36</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>1.56*</td>
<td>8.12*</td>
<td>19.20*</td>
<td>73.64*</td>
<td>98.36*</td>
<td>155.76*</td>
<td>167.02*</td>
<td>281.38*</td>
<td>262.18*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.585</td>
<td>±2.429</td>
<td>±4.608</td>
<td>±22.38</td>
<td>±43.47</td>
<td>±60.21</td>
<td>±49.63</td>
<td>±58.03</td>
<td>±53.42</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>1.42*</td>
<td>9.16*</td>
<td>22.36*</td>
<td>78.30*</td>
<td>127.76*</td>
<td>203.67*</td>
<td>212.71*</td>
<td>299.89*</td>
<td>277.53*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.451</td>
<td>±2.341</td>
<td>±5.682</td>
<td>±30.138</td>
<td>±34.68</td>
<td>±50.62</td>
<td>±29.99</td>
<td>±33.78</td>
<td>±31.51</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>1.36*</td>
<td>7.68*</td>
<td>18.94*</td>
<td>73.29*</td>
<td>105.82*</td>
<td>159.77*</td>
<td>167.18*</td>
<td>255.85*</td>
<td>236.91*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.356</td>
<td>±1.902</td>
<td>±4.166</td>
<td>±13.26</td>
<td>±26.59</td>
<td>±55.64</td>
<td>±43.02</td>
<td>±40.13</td>
<td>±35.96</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>1.31*</td>
<td>5.93*</td>
<td>14.71*</td>
<td>56.90*</td>
<td>80.88*</td>
<td>126.30*</td>
<td>148.40*</td>
<td>255.80*</td>
<td>241.09*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.418</td>
<td>±1.889</td>
<td>±4.206</td>
<td>±14.35</td>
<td>±27.326</td>
<td>±25.17</td>
<td>±78.22</td>
<td>±72.05</td>
<td>±67.84</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>1.15*</td>
<td>6.19*</td>
<td>16.42*</td>
<td>59.64*</td>
<td>87.02*</td>
<td>149.33*</td>
<td>154.98*</td>
<td>244.51*</td>
<td>228.09*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.445</td>
<td>±1.551</td>
<td>±7.919</td>
<td>±17.23</td>
<td>±21.799</td>
<td>±49.25</td>
<td>±24.16</td>
<td>±27.46</td>
<td>±25.86</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>1.44*</td>
<td>6.65*</td>
<td>17.34*</td>
<td>63.95*</td>
<td>90.71*</td>
<td>162.45*</td>
<td>176.14*</td>
<td>267.24*</td>
<td>249.9*</td>
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<tr>
<td></td>
<td></td>
<td>±0.446</td>
<td>±1.980</td>
<td>±4.507</td>
<td>±16.736</td>
<td>±29.469</td>
<td>±61.31</td>
<td>±44.44</td>
<td>±37.75</td>
<td>±35.18</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td></td>
<td>0.3151</td>
<td>1.2826</td>
<td>3.3184</td>
<td>12.4303</td>
<td>21.9208</td>
<td>36.9064</td>
<td>38.5075</td>
<td>35.5865</td>
<td>32.2701</td>
</tr>
</tbody>
</table>

± = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level.

10th Week = Flowering stage
16th Week = Harvesting stage
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Weeks after germination</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
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<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Control</td>
<td>26.55</td>
<td>17.86</td>
<td>39.51</td>
<td>40.47</td>
<td>33.46</td>
<td>34.97</td>
<td>41.68</td>
<td>21.00</td>
<td>19.97</td>
</tr>
<tr>
<td>25</td>
<td>37.48</td>
<td>29.89</td>
<td>24.00</td>
<td>30.38</td>
<td>44.20</td>
<td>38.65</td>
<td>29.71</td>
<td>20.62</td>
<td>20.37</td>
</tr>
<tr>
<td>50</td>
<td>31.72</td>
<td>25.55</td>
<td>25.40</td>
<td>38.48</td>
<td>27.14</td>
<td>24.85</td>
<td>14.10</td>
<td>11.24</td>
<td>11.35</td>
</tr>
<tr>
<td>75</td>
<td>26.17</td>
<td>24.75</td>
<td>21.99</td>
<td>18.10</td>
<td>25.13</td>
<td>34.82</td>
<td>25.73</td>
<td>15.68</td>
<td>15.17</td>
</tr>
<tr>
<td>100</td>
<td>31.72</td>
<td>31.86</td>
<td>28.59</td>
<td>25.22</td>
<td>33.79</td>
<td>19.93</td>
<td>52.68</td>
<td>28.16</td>
<td>28.14</td>
</tr>
<tr>
<td>125</td>
<td>38.54</td>
<td>25.04</td>
<td>48.20</td>
<td>28.89</td>
<td>25.04</td>
<td>32.98</td>
<td>15.59</td>
<td>11.23</td>
<td>11.33</td>
</tr>
<tr>
<td>150</td>
<td>31.00</td>
<td>29.74</td>
<td>23.98</td>
<td>26.16</td>
<td>32.48</td>
<td>37.74</td>
<td>25.40</td>
<td>14.12</td>
<td>14.07</td>
</tr>
</tbody>
</table>
induced variation has no significance after the lapse of the two previous generations, as the CV values do not differ much from that of control.

The leaf area calculated per plant under the different treatments in successive stages of growth has shown that the progenies of all the treatments have significantly reduced leaf area in the 3rd generation compared to that of control (Table-59).

Figure-23 shows the per cent variation reduction in leaf area under different treatments in 3rd generation. Although the leaf size did not vary to any significant level, the total leaf area per plant did show a higher percentage of deviation from that of control.

Table-60 shows the CV value for the different treated progenies in their own population level. The recorded value shows variation, within the population is minimised in the 3rd generation and the population of the different progenies are getting stabilized in the 3rd generation.
**Biomass study:**

The biomass study was carried out at fortnightly intervals up to 60 days and later at the harvesting stage of 120 days both on the basis of fresh weight as well as dry weight, for all the three generations of the gamma ray treated progenies. The upper ground and under ground biomass were calculated separately and also the total biomass with five replicates for each stage of plant growth and 15 replicates for the final stage.

**Upper ground biomass:** The biomass estimation of 1st generation of different treated progenies under fresh condition showed decreasing order with the increasing intensity of gamma rays employed in the treatments and the decrease in biomass was found to be significant at all stages of growth under all treatments compared to control (Table-61). The same when it was calculated on dry weight basis, it was found that it varies from the control in the treated progenies to a significant level (Table-61).

Figure-24 indicates the per cent variation of upper ground biomass of the different treated progenies compared to control. The variation trend showed an increasing order with a increasing intensity of doses under all stages of growth.

The analysis of coefficient of variation in respect of upper ground biomass has revealed that the value shows an increase
with the increasing dose at all stages of growth (Table-62).

Under ground biomass: The analysis of under ground biomass both on the basis of fresh weight (Table-63) and dry weight (Table-63) has revealed that the biomass of treated progenies in the M1 generation shows a decreasing order with increasing intensity of gamma-rays involved in the treatment. Statistical analysis of the collected data has revealed that the decreasing in biomass in the treated progenies is significant at 5 per cent level under all stages of growth as in the case of upper ground biomass. The per cent variation calculated has revealed that both the fresh weight as well as dry weight of the treated progenies varies to a considerable extent from that of control, the variation being quite high in the higher doses (Figure-24).

The analysis of coefficient of variation within the popu­lation is more under high intensity of doses than in the low intensity doses and control indicating that the treatments have induced variation in the treated progenies (Table-64).

M2 generation: The upper ground biomass estimation at fortnightly intervals of M2 generation has shown that the treated progenies differ significantly in the biomass production from that of control under all treatments and at all stages of growth both in terms of fresh weight and dry weight except in the case of 25
Table - 61  Shoot biomass of \( M_1 \) generation in terms of fresh and dry weight under different gamma-ray treatments at different intervals.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Shoot biomass</th>
<th>Days after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F.W.</td>
<td>15</td>
</tr>
<tr>
<td>Control</td>
<td>0.460 ± 0.0441</td>
<td>3.695 ± 0.4294</td>
</tr>
<tr>
<td>25</td>
<td>0.034 ± 0.0037</td>
<td>0.213* ± 0.0299</td>
</tr>
<tr>
<td>50</td>
<td>0.0172 ± 0.0022</td>
<td>0.090* ± 0.1697</td>
</tr>
<tr>
<td>75</td>
<td>0.0196 ± 0.0038</td>
<td>0.036* ± 0.0236</td>
</tr>
<tr>
<td>100</td>
<td>0.0185 ± 0.0055</td>
<td>0.054* ± 0.0129</td>
</tr>
<tr>
<td>125</td>
<td>0.0170 ± 0.0037</td>
<td>0.035* ± 0.0089</td>
</tr>
<tr>
<td>150</td>
<td>0.0166 ± 0.0058</td>
<td>0.153* ± 0.0460</td>
</tr>
<tr>
<td>0.0350* ± 0.0557</td>
<td>1.297* ± 0.2090</td>
<td>1.980* ± 0.3565</td>
</tr>
</tbody>
</table>

L.S.D. at 5% level

| D.W. | 0.002140| 0.00995| 0.04076| 0.09125| 1.4388 |

± = Standard deviation  L.S.D. = Least significant difference
* = Significant at 5% level
F.W. = Fresh weight  D.W. = Dry weight
Table - 62  Coefficient of variation for shoot biomass of $M_1$ generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Days after germination</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>F.W.</td>
<td>9.60</td>
<td>11.62</td>
<td>17.81</td>
<td>17.40</td>
<td>20.99</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>10.00</td>
<td>10.63</td>
<td>16.11</td>
<td>18.00</td>
<td>21.87</td>
</tr>
<tr>
<td>25</td>
<td>F.W.</td>
<td>11.85</td>
<td>15.43</td>
<td>18.75</td>
<td>18.17</td>
<td>77.00</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>10.77</td>
<td>14.00</td>
<td>15.59</td>
<td>16.00</td>
<td>76.78</td>
</tr>
<tr>
<td>50</td>
<td>F.W.</td>
<td>14.11</td>
<td>18.67</td>
<td>25.41</td>
<td>20.53</td>
<td>52.85</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>12.97</td>
<td>17.11</td>
<td>21.44</td>
<td>19.85</td>
<td>50.01</td>
</tr>
<tr>
<td>75</td>
<td>F.W.</td>
<td>21.67</td>
<td>19.72</td>
<td>27.00</td>
<td>21.66</td>
<td>54.43</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>19.75</td>
<td>14.98</td>
<td>25.09</td>
<td>20.18</td>
<td>55.84</td>
</tr>
<tr>
<td>100</td>
<td>F.W.</td>
<td>20.15</td>
<td>20.04</td>
<td>32.96</td>
<td>29.55</td>
<td>40.00</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>19.18</td>
<td>23.55</td>
<td>31.66</td>
<td>27.64</td>
<td>38.00</td>
</tr>
<tr>
<td>125</td>
<td>F.W.</td>
<td>24.68</td>
<td>27.55</td>
<td>34.61</td>
<td>30.08</td>
<td>59.83</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>22.09</td>
<td>24.89</td>
<td>30.66</td>
<td>29.57</td>
<td>61.55</td>
</tr>
<tr>
<td>150</td>
<td>F.W.</td>
<td>27.50</td>
<td>30.00</td>
<td>35.23</td>
<td>34.51</td>
<td>42.00</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>24.69</td>
<td>27.29</td>
<td>32.41</td>
<td>30.66</td>
<td>40.48</td>
</tr>
</tbody>
</table>

F.W. = Fresh weight
D.W. = Dry weight
Table - 63  Root biomass of $M_1$ generation in terms of fresh and dry weight under different gamma-ray treatments at different intervals.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Root biomass</th>
<th>Days after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F.W.</td>
<td>15</td>
</tr>
<tr>
<td>Control</td>
<td>0.0929</td>
<td>0.240</td>
</tr>
<tr>
<td></td>
<td>±0.0032</td>
<td>±0.0040</td>
</tr>
<tr>
<td>25</td>
<td>0.0014*</td>
<td>0.073*</td>
</tr>
<tr>
<td></td>
<td>±0.0024</td>
<td>±0.0132</td>
</tr>
<tr>
<td>50</td>
<td>0.0014*</td>
<td>0.0205*</td>
</tr>
<tr>
<td></td>
<td>±0.0022</td>
<td>±0.0013</td>
</tr>
<tr>
<td>75</td>
<td>0.0016*</td>
<td>0.0206*</td>
</tr>
<tr>
<td></td>
<td>±0.0027</td>
<td>±0.0058</td>
</tr>
<tr>
<td>100</td>
<td>0.0008*</td>
<td>0.0023*</td>
</tr>
<tr>
<td></td>
<td>±0.0016</td>
<td>±0.0056</td>
</tr>
<tr>
<td>125</td>
<td>0.0021*</td>
<td>0.0111*</td>
</tr>
<tr>
<td></td>
<td>±0.0013</td>
<td>±0.0030</td>
</tr>
<tr>
<td>150</td>
<td>0.0062*</td>
<td>0.0133*</td>
</tr>
<tr>
<td></td>
<td>±0.0013</td>
<td>±0.0034</td>
</tr>
</tbody>
</table>

L.S.D. at 5% level

| D.W.         | 0.000135 | 0.000925 | 0.004789 | 0.00950 | 0.08185 |

± = Standard deviation  L.S.D. = Least significant different
* = Significant at 5% level  F.W. = Fresh Weight
D.W. = Dry weight
Table 64 Coefficient of variation for root biomass of M₁ generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>15</td>
<td>8.01</td>
<td>9.00</td>
<td>12.20</td>
<td>12.01</td>
<td>14.60</td>
<td>15.65</td>
<td>15.70</td>
<td>16.18</td>
<td>19.80</td>
<td>20.60</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>12.66</td>
<td>12.00</td>
<td>15.11</td>
<td>14.27</td>
<td>16.42</td>
<td>15.58</td>
<td>19.17</td>
<td>18.50</td>
<td>25.79</td>
<td>24.00</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>16.53</td>
<td>15.75</td>
<td>19.61</td>
<td>18.00</td>
<td>18.88</td>
<td>17.81</td>
<td>20.44</td>
<td>18.50</td>
<td>25.97</td>
<td>26.41</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>18.48</td>
<td>16.84</td>
<td>20.95</td>
<td>19.00</td>
<td>23.66</td>
<td>26.41</td>
<td>25.23</td>
<td>19.20</td>
<td>24.13</td>
<td>26.41</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>21.7</td>
<td>20.87</td>
<td>70.61</td>
<td>69.93</td>
<td>61.24</td>
<td>60.82</td>
<td>65.90</td>
<td>24.13</td>
<td>50.87</td>
<td>48.08</td>
</tr>
<tr>
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<td></td>
<td></td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>100</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F.W. = Fresh weight
D.W. = Dry weight
FIG. 24
krad treatment in which no significance difference occurred in biomass at their early stages of growth (Table-65).

Figure-25, indicates the per cent variation in biomass production by the different treated progenies in their $M_2$ generation. All the treated progenies showed a reduction in their biomass content compared to that of control.

Under ground biomass: The under ground biomass estimation of 2nd generation has shown that the high intensity doses (125 and 150 krad) caused significant reduction in under ground biomass production at all stages of growth. Under 100 krad treatment, also the under ground biomass was found to be significantly less at all stages except that of 60 day stage. 75 krad treatment has shown reduced biomass content at 30, 45 and 120 day old stages, whereas 50 krad treatment yielded no significant difference at 60 day old stage. In 25 krad treatment, root biomass significantly differed from that of control at 45 and 120 days old stages (Table-67).

The under ground biomass on the basis of dry weight also has shown more or less the same results as that of fresh weight (Table-67).

The variation percentage calculated in terms of fresh and dry weight revealed that the treated progenies showed a
reduction in biomass production except 25 krad treatment in which the plants showed a marginal increase in the first three stages in terms of fresh weight and at the 1st and 2nd stages in terms of dry weight. The variation percentage has been found to be high at the last stage of analysis in all the treatments, except the 125 krad treatment in which the highest percentage of variation was found to occur in 30 day old seedlings in terms of fresh weight. The root biomass showed a different percentage variation on dry mass basis. The first three and the last treatment recorded highest percentage of variation at the time of harvest, whereas the 100 and 125 krad treatments recorded highest variation in 30 day old stage (Figure-25).

The analysis of variance within the population of the different treated progenies has revealed that the variation is not high in the 2nd generation as in the case of the 1st. The highest variation was recorded under all treatments at the harvesting stage (Table-68).

M₃ generation: The upper ground biomass estimation of the 3rd generation has revealed that the treated progenies significantly differed in biomass from that of control under all treatments irrespective of the strength of gamma-rays both in terms of fresh and dry weight. However, in the case of later, a slight deviation from that of the general trend has been observed in some cases, particularly of the lower doses (Table-69).
Table - 65  Shoot biomass of $M_2$ generation in terms of fresh and dry weight under different gamma-ray treatments at different intervals.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Shoot biomass</th>
<th>Days after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F.W.</td>
<td>15</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F.W.</td>
<td>0.657</td>
</tr>
<tr>
<td></td>
<td>±0.0855</td>
<td>±0.4647</td>
</tr>
<tr>
<td>25</td>
<td>D.W.</td>
<td>0.0667</td>
</tr>
<tr>
<td></td>
<td>±0.00714</td>
<td>±0.0599</td>
</tr>
<tr>
<td></td>
<td>F.W.</td>
<td>0.636</td>
</tr>
<tr>
<td></td>
<td>±0.1069</td>
<td>±0.5102</td>
</tr>
<tr>
<td>50</td>
<td>D.W.</td>
<td>0.0627</td>
</tr>
<tr>
<td></td>
<td>±0.00991</td>
<td>±0.05523</td>
</tr>
<tr>
<td></td>
<td>F.W.</td>
<td>0.340*</td>
</tr>
<tr>
<td></td>
<td>±0.0695</td>
<td>±0.2762</td>
</tr>
<tr>
<td>75</td>
<td>D.W.</td>
<td>0.0410*</td>
</tr>
<tr>
<td></td>
<td>±0.01062</td>
<td>±0.0312</td>
</tr>
<tr>
<td>100</td>
<td>F.W.</td>
<td>0.485*</td>
</tr>
<tr>
<td></td>
<td>±0.1062</td>
<td>±0.3254</td>
</tr>
<tr>
<td>125</td>
<td>D.W.</td>
<td>0.0412*</td>
</tr>
<tr>
<td></td>
<td>±0.0080</td>
<td>±0.0427</td>
</tr>
<tr>
<td>150</td>
<td>F.W.</td>
<td>0.412*</td>
</tr>
<tr>
<td></td>
<td>±0.1027</td>
<td>±0.2621</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>D.W.</td>
<td>0.00587</td>
</tr>
</tbody>
</table>

± = Standard deviation  L.S.D. = Least significant difference  
* = Significant at 5% level  
F.W. = Fresh weight  
D.W. = Dry weight
Table - 66  Coefficient of variation for shoot biomass of M_2 generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Days after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>13.00</td>
</tr>
<tr>
<td>D.W.</td>
<td>10.70</td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>16.80</td>
</tr>
<tr>
<td>D.W.</td>
<td>15.80</td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>20.40</td>
</tr>
<tr>
<td>D.W.</td>
<td>16.40</td>
</tr>
<tr>
<td>75</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>21.90</td>
</tr>
<tr>
<td>D.W.</td>
<td>19.6</td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>24.90</td>
</tr>
<tr>
<td>D.W.</td>
<td>18.10</td>
</tr>
<tr>
<td>125</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>27.8</td>
</tr>
<tr>
<td>D.W.</td>
<td>21.20</td>
</tr>
<tr>
<td>150</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>26.88</td>
</tr>
<tr>
<td>D.W.</td>
<td>25.90</td>
</tr>
</tbody>
</table>

F.W. = Fresh weight
D.W. = Dry weight
Table - 67  Root biomass of \( M_2 \) generation in terms of fresh and dry weight under different gamma-ray treatments at different intervals.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Root biomass</th>
<th>Days after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F.W.</td>
<td>15</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F.W. 0.038</td>
<td>0.164</td>
</tr>
<tr>
<td></td>
<td>± 0.0049</td>
<td>± 0.0259</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.00391</td>
<td>0.0244</td>
</tr>
<tr>
<td></td>
<td>± 0.000458</td>
<td>± 0.00436</td>
</tr>
<tr>
<td>25</td>
<td>F.W. 0.043*</td>
<td>0.174</td>
</tr>
<tr>
<td></td>
<td>± 0.0059</td>
<td>± 0.0324</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.00472</td>
<td>0.0238</td>
</tr>
<tr>
<td></td>
<td>± 0.000594</td>
<td>± 0.00397</td>
</tr>
<tr>
<td>50</td>
<td>F.W. 0.022*</td>
<td>0.0991</td>
</tr>
<tr>
<td></td>
<td>± 0.0036</td>
<td>± 0.0190</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.0020*</td>
<td>0.0138*</td>
</tr>
<tr>
<td></td>
<td>± 0.000294</td>
<td>± 0.00283</td>
</tr>
<tr>
<td>75</td>
<td>F.W. 0.034</td>
<td>0.106</td>
</tr>
<tr>
<td></td>
<td>± 0.0068</td>
<td>± 0.0218</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.00293*</td>
<td>0.01610*</td>
</tr>
<tr>
<td></td>
<td>± 0.000474</td>
<td>± 0.00286</td>
</tr>
<tr>
<td>100</td>
<td>F.W. 0.027*</td>
<td>0.0837*</td>
</tr>
<tr>
<td></td>
<td>± 0.0050</td>
<td>± 0.0179*</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.00233*</td>
<td>0.01048*</td>
</tr>
<tr>
<td></td>
<td>± 0.00039</td>
<td>± 0.0023</td>
</tr>
<tr>
<td>125</td>
<td>F.W. 0.031*</td>
<td>0.0610*</td>
</tr>
<tr>
<td></td>
<td>± 0.0066</td>
<td>± 0.0172</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.0021*</td>
<td>0.0098*</td>
</tr>
<tr>
<td></td>
<td>± 0.00044</td>
<td>± 0.0025</td>
</tr>
<tr>
<td>150</td>
<td>F.W. 0.027*</td>
<td>0.085*</td>
</tr>
<tr>
<td></td>
<td>± 0.0067</td>
<td>± 0.0275</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.00241*</td>
<td>0.0139*</td>
</tr>
<tr>
<td></td>
<td>± 0.00064</td>
<td>± 0.00429</td>
</tr>
<tr>
<td>L.S.D.</td>
<td>F.W. 0.00484</td>
<td>0.0185</td>
</tr>
<tr>
<td>at 5% level</td>
<td>D.W. 0.000471</td>
<td>0.003317</td>
</tr>
</tbody>
</table>

± = Standard deviation, L.S.D. = Least significant difference,
* = Significant at 5% level, F.W. = Fresh Weight, D.W. = Dry Weight
Table - 68 Coefficient of variation for root biomass of M₂ generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Days after germination</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>F.W.</td>
<td>12.80</td>
<td>15.80</td>
<td>16.20</td>
<td>19.60</td>
<td>22.86</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>11.70</td>
<td>17.90</td>
<td>14.30</td>
<td>18.10</td>
<td>23.59</td>
</tr>
<tr>
<td>25</td>
<td>F.W.</td>
<td>13.90</td>
<td>18.60</td>
<td>18.50</td>
<td>27.80</td>
<td>28.95</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>14.00</td>
<td>16.70</td>
<td>15.60</td>
<td>26.30</td>
<td>30.91</td>
</tr>
<tr>
<td>50</td>
<td>F.W.</td>
<td>16.10</td>
<td>19.20</td>
<td>22.90</td>
<td>28.50</td>
<td>34.69</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>14.70</td>
<td>20.50</td>
<td>21.80</td>
<td>26.40</td>
<td>32.69</td>
</tr>
<tr>
<td>75</td>
<td>F.W.</td>
<td>19.60</td>
<td>20.50</td>
<td>28.40</td>
<td>32.80</td>
<td>52.70</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>16.20</td>
<td>17.80</td>
<td>25.70</td>
<td>31.90</td>
<td>50.51</td>
</tr>
<tr>
<td>100</td>
<td>F.W.</td>
<td>18.50</td>
<td>21.40</td>
<td>36.20</td>
<td>36.70</td>
<td>58.19</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>16.90</td>
<td>22.70</td>
<td>32.50</td>
<td>33.50</td>
<td>55.71</td>
</tr>
<tr>
<td>125</td>
<td>F.W.</td>
<td>21.40</td>
<td>28.30</td>
<td>38.30</td>
<td>41.00</td>
<td>50.00</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>20.6</td>
<td>25.80</td>
<td>34.90</td>
<td>40.00</td>
<td>48.30</td>
</tr>
<tr>
<td>150</td>
<td>F.W.</td>
<td>24.70</td>
<td>32.10</td>
<td>40.70</td>
<td>50.60</td>
<td>72.56</td>
</tr>
<tr>
<td></td>
<td>D.W.</td>
<td>26.80</td>
<td>30.90</td>
<td>38.70</td>
<td>45.90</td>
<td>70.61</td>
</tr>
</tbody>
</table>

F.W. = Fresh weight  
D.W. = Dry weight
**M<sub>2</sub> GENERATION**

**PERCENT VARIATION IN SHOOT BIOMASS (M<sub>2</sub>)**

- **FRESH WT.**
- **DRY WT.**

DOSSES IN KRAD

**FIG. 25**
Variation percentage on fresh and dry weight basis has revealed that the treated progenies showed a considerable decrease from that of control (Figure-26) except in one case of 25 krad treatment at 30 day old stage.

The analysis of coefficient of variation of 3rd generation has revealed that it shows higher value in higher doses than in the lower ones (Table-70).

The under ground biomass estimation of the 3rd generation has revealed that it follows the same general trend as that of upper ground biomass both in terms of fresh weight and dry weight (Table-71).

Figure-26, shows the per cent variation in under ground biomass of different treatments. Variation percentage goes to the highest in 30 day old stage in case of 100, 125 and 150 krad treatments, whereas the highest per cent variation was recorded at the last stage in the case of the first three lower doses. However in terms of dry weight the highest value of variation was found to occur in 25 and 50 krad treatment at 45 day old stage and so also in 100 and 150 krad treatment. In case of 75 and 125 krad treatments a highest per cent variation has been noted at the last stage (Figure-26).

The biomass analysis of the different treated progenies in different generations on the basis of fresh and dry weight has
<table>
<thead>
<tr>
<th>Doses in Krads</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.611 ± 0.1032</td>
<td>0.0608 ± 0.0995</td>
<td>0.463* ± 0.0643</td>
<td>0.0567 ± 0.0099</td>
<td>0.375* ± 0.0648</td>
</tr>
<tr>
<td>25</td>
<td>3.267 ± 0.5620</td>
<td>0.3152 ± 0.0520</td>
<td>2.571* ± 0.5219</td>
<td>0.322 ± 0.0506</td>
<td>1.687* ± 0.4287</td>
</tr>
<tr>
<td>50</td>
<td>9.043 ± 1.7544</td>
<td>1.488 ± 0.2351</td>
<td>4.614* ± 0.9828</td>
<td>0.807* ± 0.1767</td>
<td>4.562* ± 1.1178</td>
</tr>
<tr>
<td>75</td>
<td>10.998 ± 2.4857</td>
<td>2.0827 ± 0.4956</td>
<td>7.485* ± 2.1481</td>
<td>1.727 ± 0.5319</td>
<td>8.640* ± 2.6007</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.04473</td>
<td>0.19774</td>
<td>0.4150</td>
<td>2.0643</td>
<td></td>
</tr>
</tbody>
</table>

† = Standard deviation, L.S.D. = Least significant difference
* = Significant at 5% level, F.W. = Fresh weight, D.W. = Dry weight.
Table - 70  Coefficient of variation for shoot biomass of M₂ generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Days after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>16.90</td>
</tr>
<tr>
<td>D.W.</td>
<td>15.70</td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>18.20</td>
</tr>
<tr>
<td>D.W.</td>
<td>17.50</td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>17.30</td>
</tr>
<tr>
<td>D.W.</td>
<td>17.80</td>
</tr>
<tr>
<td>75</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>21.50</td>
</tr>
<tr>
<td>D.W.</td>
<td>18.60</td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>18.30</td>
</tr>
<tr>
<td>D.W.</td>
<td>21.80</td>
</tr>
<tr>
<td>125</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>22.40</td>
</tr>
<tr>
<td>D.W.</td>
<td>19.70</td>
</tr>
<tr>
<td>150</td>
<td></td>
</tr>
<tr>
<td>F.W.</td>
<td>21.80</td>
</tr>
<tr>
<td>D.W.</td>
<td>20.1</td>
</tr>
</tbody>
</table>

F.W. = Fresh weight
D.W. = Dry weight
Table - 71  Root biomass of \( M_2 \) generation in terms of fresh and dry weight under different gamma-ray treatments at different intervals.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Root biomass</th>
<th>Days after germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>F.W. 0.044</td>
<td>±0.0074</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.0044</td>
<td>±0.0068</td>
</tr>
<tr>
<td>25</td>
<td>F.W. 0.029</td>
<td>±0.0057</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.00358</td>
<td>±0.0065</td>
</tr>
<tr>
<td>50</td>
<td>F.W. 0.025</td>
<td>±0.0039</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.0022</td>
<td>±0.0031</td>
</tr>
<tr>
<td>75</td>
<td>F.W. 0.0304</td>
<td>±0.0052</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.0037</td>
<td>±0.0057</td>
</tr>
<tr>
<td>100</td>
<td>F.W. 0.030*</td>
<td>±0.0056</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.0028</td>
<td>±0.0037</td>
</tr>
<tr>
<td>125</td>
<td>F.W. 0.022*</td>
<td>±0.0048</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.0023</td>
<td>±0.0047</td>
</tr>
<tr>
<td>150</td>
<td>F.W. 0.022*</td>
<td>±0.0045</td>
</tr>
<tr>
<td></td>
<td>D.W. 0.0019</td>
<td>±0.0042</td>
</tr>
<tr>
<td></td>
<td>F.W. 0.00506</td>
<td>±0.0051</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>L.S.D. at 5% level</th>
<th>F.W.</th>
<th>D.W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>±0.00501</td>
<td>0.00315</td>
</tr>
<tr>
<td>30</td>
<td>0.01286</td>
<td>0.02968</td>
</tr>
<tr>
<td>45</td>
<td>0.09637</td>
<td></td>
</tr>
</tbody>
</table>

\( \pm \) = Standard deviation,  
L.S.D. = Least significant difference,  
* = Significant at 5% level,  
F.W. = Fresh weight,  
D.W. = Dry weight
Table - 72 Coefficient of variation for root biomass of M$_3$ generation under different gamma-ray treatments.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Days after germination</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>16.60</td>
<td>15.30</td>
<td>17.30</td>
<td>18.40</td>
<td>15.90</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>17.30</td>
<td>16.70</td>
<td>20.80</td>
<td>22.30</td>
<td>18.40</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.90</td>
<td>14.20</td>
<td>19.50</td>
<td>26.50</td>
<td>17.90</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>17.20</td>
<td>15.30</td>
<td>19.30</td>
<td>19.50</td>
<td>24.70</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>18.50</td>
<td>16.10</td>
<td>22.70</td>
<td>28.70</td>
<td>23.80</td>
</tr>
<tr>
<td>125</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>21.60</td>
<td>20.50</td>
<td>23.80</td>
<td>22.40</td>
<td>21.60</td>
</tr>
<tr>
<td>150</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20.50</td>
<td>21.70</td>
<td>20.70</td>
<td>25.80</td>
<td>20.10</td>
</tr>
</tbody>
</table>

F.W. = Fresh Weight  
D.W. = Dry Weight
M₃ GENERATION

PERCENT VARIATION IN SHOOT BIOMASS (M₃)

PERCENT VARIATION IN ROOT BIOMASS (M₃)

DOSES IN KRAD

FIG. 26
been depicted in Figure-27 both in terms of fresh and dry weight. The biomass content has been found to be less in the 1st generation compared to the 2nd generation. In the 3rd generation the same has been found to decrease but not to the level of 1st generation except in the case of 25 krad treatment in which the biomass content of 3rd generation was found to be lesser than what was recorded in the 1st generation.

Figure-28, shows the dry matter distribution in the root and shoot of the different treated progenies in different generation along with that of control. The 25 krad treatment of \(M_1\) generation had shown a higher dry matter content per cm of root than the others. The same treatment in 2nd generation had brought about a decline in root biomass distribution and this was followed by a rise in \(M_3\) generation. But in the case of shoot system the biomass distribution was found to be the highest in the 2nd generation and not in the 1st. Under 50 krad treatment, the 2nd generation recorded the lowest value for dry matter distribution per cm length of root system while the 3rd generation recorded the highest. However, in the case of shoot system, it was found that the 2nd generation showed a better biomass value per cm than the 1st, while the highest was found in the 3rd generation. In the rest of the treatments the root biomass value followed a similar trend in having the highest value in 2nd generation which was
FRESH WEIGHT (M1)  DRY WEIGHT (M1)
FRESH WEIGHT (M2)  DRY WEIGHT (M2)
FRESH WEIGHT (M3)  DRY WEIGHT (M3)

Fig. 27
FIG. 28
followed by 3rd, while the 1st recording the lowest. The biomass content of shoot system per cm length of shoot axis has revealed that in 75 krad treatment the trend followed that of 50 krad treatment while in the rest, highest value has been noted in 2nd generation and the lowest in the 1st (Figure-28).

The water holding capacity of the different treated progenies as well as control was calculated on the basis of water content per gram of dry matter. The Figure-29 illustrates the water holding capacity of the different treated progenies in the different generations. In M₁ generation the water holding capacity gradually increases with the increasing intensity of doses. The high intensity doses like 100 krad and above, the water holding capacity showed a higher value than that of control, the increase being as high as 85.67 per cent in case of 125 krad treatment. In the first three treatments of lower doses, the water content per gram of dry matter fell short of the control (Figure-29). In the 2nd generation the water holding capacity was found to be less in higher doses compared to 1st generation and to that of control. However the same was found to be higher in 50 and 75 krad treatments than control. In 3rd generation, again the 125 krad treatment showed a higher value of water content than that of control, while the 150 krad treatment recorded a minor increase over that of control. In the rest of the treatments the water content was found to be lesser than that of the control.
Reproductive Phase:

The linseed crop generally enters its reproductive phase by the 8th week after sowing but the high intensity progenies flower a little later i.e. in the 9th or 10th week after sowing. The floral branches developing after 8 weeks of vegetative growth in control as well as in low intensity doses, flower in acropetal order.

The number of flowers per plant when compared in different treatments has revealed that the treated progenies differ significantly from that of control in having lesser number of flowers per plant. The progeny of 25 krad treatment proved to be an exception to the above as it produced no significant reduction in number of flowers compared to that of control (Table-73).

Analysis of coefficient of variation does not show the same trend as it did in the other parameters studied under vegetative phase. The variation has been found to be very wide in the low intensity doses while the high intensity doses showed lesser variation within the population (Table-73).

Figure-30 indicates the per cent variation of flower number in $M_1$ generation. There is a considerable reduction in the number of flowers per plant in the treated progenies.
Table - 73  Effect of different gamma ray doses on the reproductive phase of *Linum usitatissimum* L. var. Mukta in M<sub>1</sub> generation.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Number of flowers and fruits per plant</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flowers</td>
<td>Fruits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>CV</td>
<td>Mean</td>
</tr>
<tr>
<td>Control</td>
<td>100.66</td>
<td>43.52</td>
<td>75.73</td>
</tr>
<tr>
<td></td>
<td>± 43.81</td>
<td></td>
<td>±38.74</td>
</tr>
<tr>
<td>25</td>
<td>76.73</td>
<td>69.67</td>
<td>50.53*</td>
</tr>
<tr>
<td></td>
<td>± 53.46</td>
<td></td>
<td>±37.43</td>
</tr>
<tr>
<td>50</td>
<td>53.13*</td>
<td>58.94</td>
<td>26.00*</td>
</tr>
<tr>
<td></td>
<td>± 31.32</td>
<td></td>
<td>±17.92</td>
</tr>
<tr>
<td>75</td>
<td>52.40*</td>
<td>52.06</td>
<td>19.06*</td>
</tr>
<tr>
<td></td>
<td>± 27.28</td>
<td></td>
<td>±13.11</td>
</tr>
<tr>
<td>100</td>
<td>72.07*</td>
<td>64.89</td>
<td>6.73*</td>
</tr>
<tr>
<td></td>
<td>± 46.77</td>
<td></td>
<td>±6.27</td>
</tr>
<tr>
<td>125</td>
<td>54.00*</td>
<td>44.46</td>
<td>6.400*</td>
</tr>
<tr>
<td></td>
<td>± 24.01</td>
<td></td>
<td>±5.14</td>
</tr>
<tr>
<td>150</td>
<td>53.75*</td>
<td>37.20</td>
<td>7.13*</td>
</tr>
<tr>
<td></td>
<td>± 20.76</td>
<td></td>
<td>±6.52</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>25.6721</td>
<td>16.6464</td>
<td></td>
</tr>
</tbody>
</table>

<sup>+</sup> = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level  
CV = Coefficient of variation
Fruit set:-

All flowers which bloomed in a plant did not develop into fruits under all treatments as well as in control. The fruit number, as compared to control, has been found to be significantly less under all treatments (Table-73), the percentage being quite high touching up to 96% under high intensity doses (Figure-30).

The analysis of coefficient of variation has shown quite a high value under high intensity doses indicating the degree of variation within the population in fruit setting as induced by gamma-ray treatment (Table-73).

Number of seeds:-

Number of seeds per fruit and per plant were also analysed under different treatments. Table-74 summarises the results regarding the above. It is clear from the data that both, the number of seeds per fruit and the seeds per plant, decrease significantly under the different treatments compared to that of control.

Similarly the seeds weight also went down to a significant extent under all treatments, compared to control except in a single case of 125 krad treatments (Table-74).
Yield:

When the yield was calculated on the basis of seed weight per plot it has been found that the treated progenies in the M₁ generation yielded significantly less quantity of seeds per plot compared to that of control (Table-74). The per cent variation calculated in this regard (seeds per fruit, seeds per plant, weight of 1000 seeds and seed yield per plot) has been given in Figure-30. It is clear from the figure that the yield per plot has gone down considerably in the treated progenies. The percentage of loss has been calculated to be as high as 82.82% even in a dose like that of 50 krad treatment. Under high intensity doses (100, 125 & 150 krad) the reduction in yield has gone up to 98 and 99 per cent (Figure-30). It is noteworthy here that the weight of seeds per 1000 has shown a slight improvement under high doses like 125 and 150 krad treatments compared to control, although the seed number per fruit and seeds per plant have gone down badly (Figure-30).

Table-75 shows the value of coefficient of variation in the different populations in regard to seed number and seed weight. Here also the number of seeds per plant showed high degree of variation within the different populations under different treatments. But the seed weight variation did not show the same trend.
Table - 74  Effect of different gamma ray treatment on the yield of *Linum usitatissimum* L. var. Mukta in *M*₂ generation.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Number of seeds</th>
<th>Weight in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per fruit</td>
<td>Per plant</td>
</tr>
<tr>
<td>Control</td>
<td>7.802 ±0.932</td>
<td>590.8 ±302.27</td>
</tr>
<tr>
<td>25</td>
<td>5.916 ±0.992</td>
<td>298.9 ±212.97</td>
</tr>
<tr>
<td>50</td>
<td>4.628 ±1.404</td>
<td>120.3 ±78.67</td>
</tr>
<tr>
<td>75</td>
<td>3.681 ±0.923</td>
<td>70.10 ±51.53</td>
</tr>
<tr>
<td>100</td>
<td>3.076 ±1.739</td>
<td>20.70 ±18.45</td>
</tr>
<tr>
<td>125</td>
<td>2.414 ±0.521</td>
<td>15.40 ±13.27</td>
</tr>
<tr>
<td>150</td>
<td>2.270 ±0.480</td>
<td>16.10 ±14.07</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.7561</td>
<td>70.8351</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level
Table - 75  Coefficient of variation for yield of M₁ generation of *Linum usitatissimum* L. var. Mukta under different gamma ray treatment.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>No. of seeds/fruit</th>
<th>No. of seeds/plant</th>
<th>Weight of 1000 seeds</th>
<th>Weight of total seed/plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>11.95</td>
<td>51.16</td>
<td>2.35</td>
<td>7.66</td>
</tr>
<tr>
<td>25</td>
<td>16.78</td>
<td>71.25</td>
<td>2.49</td>
<td>7.95</td>
</tr>
<tr>
<td>50</td>
<td>30.35</td>
<td>65.39</td>
<td>3.09</td>
<td>9.12</td>
</tr>
<tr>
<td>75</td>
<td>25.08</td>
<td>73.50</td>
<td>3.99</td>
<td>10.82</td>
</tr>
<tr>
<td>100</td>
<td>56.55</td>
<td>89.13</td>
<td>4.69</td>
<td>11.44</td>
</tr>
<tr>
<td>125</td>
<td>21.59</td>
<td>86.16</td>
<td>3.89</td>
<td>12.73</td>
</tr>
<tr>
<td>150</td>
<td>21.16</td>
<td>87.41</td>
<td>3.17</td>
<td>15.81</td>
</tr>
</tbody>
</table>
FIG. 30

PV IN NO. OF FLOWERS/PLANT

PV IN NO. OF FRUITS/PLANT

PV IN NO. OF SEEDS/FRUIT

PV IN NO. OF SEEDS/PLANT

PV IN WT. OF 1000 SEEDS IN GMS.

PV IN YIELD/PLLOT

A - 25 Krad
B - 50 Krad
C - 75 Krad

D - 100 Krad
E - 125 Krad
F - 150 Krad

PV - PER CENT VARIATION
The plants of \( M_2 \) generation developed floral buds in the 7th week after sowing. The number of flowers per plant in \( M_2 \) generation significantly differed from that of control in the different treated progenies except the 125 krad treatment. The analysis of coefficient of variation has shown a high value for the 2nd generation. Under all treatments the value of CV happened to be high compared to control except the 50 krad treatment in which it was found to be less both in terms of flower per plant as well as fruit per plant (Table-76).

The flowering and fruiting, when compared, it has been found that it is less in the treated progenies than in the control (Figure-31). Similarly the seed weight and the yield in 2nd generation have shown that there is a significant reduction in seed weight under 25, 50, 125 and 150 krad treatments, while in 75 and 100 krad treatments, the seed weight did not differ compared to control. However the number of seeds per plant and the seed yield per plot showed that the gamma-ray treatments affect the seed output and the yield per plot to a significant level compared to control (Table-77).

Figure-31 shows the per cent variation in seed number and seed weight under different treatments. Both the seed number as well as the yield showed a high reduction in the treated progenies.
Table - 76 Effect of different gamma-ray doses on the reproductive phase of *Linum usitatissimum* L. var. Mukta in *M₂* generation.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Number of flowers and fruits per plant</th>
<th>Mean</th>
<th>CV</th>
<th>Mean</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>99.00</td>
<td>40.51</td>
<td>70.83</td>
<td>54.69</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±40.11</td>
<td>±38.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>56.73*</td>
<td>73.55</td>
<td>44.33*</td>
<td>79.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±41.73</td>
<td>±35.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>47.6*</td>
<td>37.16</td>
<td>33.53*</td>
<td>38.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±17.69</td>
<td>±13.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>45.06*</td>
<td>45.62</td>
<td>30.06*</td>
<td>66.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±20.56</td>
<td>±20.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>59.06*</td>
<td>70.55</td>
<td>40.73*</td>
<td>66.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±41.67</td>
<td>±27.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>74.00</td>
<td>55.79</td>
<td>46.20*</td>
<td>64.28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±41.29</td>
<td>±29.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>59.40*</td>
<td>79.09</td>
<td>37.60*</td>
<td>75.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±46.98</td>
<td>±28.37</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

L.S.D. at 5% level

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30.721</td>
</tr>
<tr>
<td></td>
<td>19.788</td>
</tr>
</tbody>
</table>

± = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level
CV = Coefficient of variation
Table - 77 Effect of different gamma ray treatment on the yield of *Linum usitatissimum* L. var. Mukta in *M₂* generation.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Number of seeds</th>
<th>Weight in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per fruit</td>
<td>Per plant</td>
</tr>
<tr>
<td>Control</td>
<td>7.733 ± 0.941</td>
<td>547.72 ± 270.65</td>
</tr>
<tr>
<td>25</td>
<td>6.173* ± 0.554</td>
<td>273.6* ± 216.05</td>
</tr>
<tr>
<td>50</td>
<td>5.853* ± 0.913</td>
<td>196.20* ± 74.91</td>
</tr>
<tr>
<td>75</td>
<td>6.466* ± 1.402</td>
<td>194.3* ± 116.38</td>
</tr>
<tr>
<td>100</td>
<td>6.893* ± 0.639</td>
<td>280.7* ± 172.32</td>
</tr>
<tr>
<td>125</td>
<td>5.30* ± 0.822</td>
<td>245.1* ± 132.65</td>
</tr>
<tr>
<td>150</td>
<td>5.50* ± 1.048</td>
<td>206.8* ± 143.0</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.7138</td>
<td>120.42</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Number of seeds/fruit</th>
<th>Number of seeds/plant</th>
<th>Weight of 1000 seeds in grams</th>
<th>Weight of total seeds in grams/plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>12.17</td>
<td>49.41</td>
<td>2.90</td>
<td>7.11</td>
</tr>
<tr>
<td>25</td>
<td>8.97</td>
<td>78.94</td>
<td>2.88</td>
<td>7.41</td>
</tr>
<tr>
<td>50</td>
<td>15.60</td>
<td>38.18</td>
<td>3.59</td>
<td>8.62</td>
</tr>
<tr>
<td>75</td>
<td>21.69</td>
<td>59.89</td>
<td>3.70</td>
<td>9.10</td>
</tr>
<tr>
<td>100</td>
<td>9.27</td>
<td>61.38</td>
<td>4.00</td>
<td>9.72</td>
</tr>
<tr>
<td>125</td>
<td>15.50</td>
<td>54.12</td>
<td>3.89</td>
<td>8.93</td>
</tr>
<tr>
<td>150</td>
<td>19.05</td>
<td>69.14</td>
<td>3.49</td>
<td>10.46</td>
</tr>
</tbody>
</table>
**M₂ GENERATION**

**FIG. 31**

- PV IN NO. OF FLOWERS/PLANT
- PV IN NO. OF FRUITS/PLANT
- PV IN NO. OF SEEDS/FRUIT
- PV IN NO. OF SEEDS/PLANT
- PV IN WT. OF 1000 SEEDS IN GMS.
- PV IN YIELD/PLANT

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV IN NO. OF FLOWERS/PLANT</td>
<td>50</td>
<td>60</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>PV IN NO. OF FRUITS/PLANT</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>40</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>PV IN NO. OF SEEDS/FRUIT</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>PV IN NO. OF SEEDS/PLANT</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>PV IN WT. OF 1000 SEEDS IN GMS.</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>PV IN YIELD/PLANT</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
</tr>
</tbody>
</table>

A—25 KRAD
B—50 KRAD
C—75 KRAD
D—100 KRAD
E—125 KRAD
F—150 KRAD

PV—PERCENT VARIATION
Table-78 shows the analysis of coefficient of variation in regard to seed number and seed weight.

M₃ generation-

Table-79 illustrates the number of flowers and fruits per plant of the progenies under different treatments. The number of seeds per plant were analysed in 3rd generation. It has also shown that there has been a considerable reduction in the treated progenies even in the 3rd generation, indicating the effect of ionizing radiation to prolong even after 2nd generation to a significant level (Table-80, Figure-32), although the coefficient of variation goes around the control (Table-81). The number of seeds per fruit did not differ to a significant level in the different treated progenies except in the two higher doses like 150 and 125 krad treatments. But the seed number per plant differed to a significant level in 3rd generation under all treatments compared to control. The seed weight per thousand also showed significant reduction in the different treated progenies in M₃ generation compared to that of control, with the exception of 150 krad treatment. As a consequence of the above the seed output in terms of seed weight showed significant reduction under all treatments compared to control even in the 3rd generation, indicating the prolonged effect of gamma-ray treatments (Table-80).
Table - 79  Effect of different gamma ray doses on the reproductive phase of *Linum usitatissimum* L. var. Mukta in *M*₂ generation.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Number of flowers and fruits per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Control</td>
<td>94.78</td>
</tr>
<tr>
<td></td>
<td>±38.17</td>
</tr>
<tr>
<td>25</td>
<td>48.00*</td>
</tr>
<tr>
<td></td>
<td>±23.11</td>
</tr>
<tr>
<td>50</td>
<td>64.80*</td>
</tr>
<tr>
<td></td>
<td>±40.41</td>
</tr>
<tr>
<td>75</td>
<td>73.13</td>
</tr>
<tr>
<td></td>
<td>±42.89</td>
</tr>
<tr>
<td>100</td>
<td>56.53*</td>
</tr>
<tr>
<td>125</td>
<td>48.40*</td>
</tr>
<tr>
<td></td>
<td>±25.65</td>
</tr>
<tr>
<td>150</td>
<td>50.86*</td>
</tr>
<tr>
<td></td>
<td>±27.55</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>29.106</td>
</tr>
</tbody>
</table>

± = Standard deviation,  L.S.D. = Least significant difference  
* = Significant at 5% level  
CV = Coefficient of variation.
### Table - 80
Effect of different gamma ray treatment on the yield of *Linum usitatissimum* L. var. Mukta in *M₃* generation.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Number of seeds</th>
<th>Weight in grams</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per fruit</td>
<td>Per plant</td>
<td>1000 seeds</td>
</tr>
<tr>
<td>Control</td>
<td>7.60 ± 0.953</td>
<td>556.37 ± 273.81</td>
<td>10.86 ± 0.309</td>
</tr>
<tr>
<td>25</td>
<td>7.18 ± 0.598</td>
<td>228.3 * ± 122.06</td>
<td>9.909 * ± 0.258</td>
</tr>
<tr>
<td>50</td>
<td>7.50 ± 0.592</td>
<td>282.9 * ± 142.50</td>
<td>10.203 * ± 0.255</td>
</tr>
<tr>
<td>75</td>
<td>7.06 ± 0.693</td>
<td>300.0 * ± 158.98</td>
<td>9.945 * ± 0.288</td>
</tr>
<tr>
<td>100</td>
<td>7.40 ± 0.789</td>
<td>223.9 * ± 115.44</td>
<td>11.763 * ± 0.337</td>
</tr>
<tr>
<td>125</td>
<td>6.94 * ± 0.938</td>
<td>206.3 * ± 117.98</td>
<td>11.774 * ± 0.348</td>
</tr>
<tr>
<td>150</td>
<td>6.71 * ± 0.906</td>
<td>273.9 * ± 117.98</td>
<td>10.998 ± 0.329</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.5485</td>
<td>111.635</td>
<td>0.2439</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
Table - 81 Coefficient of variation for the yield of M₃ generation of *Linum usitatissimum* L. var. *Mukta* under different gamma-ray treatment.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Number of seeds/fruit</th>
<th>Number of seeds/plant</th>
<th>Weight of 1000 seeds in grams</th>
<th>Weight of total seeds in gram/plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>12.53</td>
<td>49.21</td>
<td>2.84</td>
<td>7.00</td>
</tr>
<tr>
<td>25</td>
<td>8.32</td>
<td>53.43</td>
<td>2.60</td>
<td>7.40</td>
</tr>
<tr>
<td>50</td>
<td>7.89</td>
<td>50.37</td>
<td>2.50</td>
<td>6.95</td>
</tr>
<tr>
<td>75</td>
<td>9.81</td>
<td>52.99</td>
<td>2.89</td>
<td>7.16</td>
</tr>
<tr>
<td>100</td>
<td>10.66</td>
<td>51.55</td>
<td>2.86</td>
<td>8.26</td>
</tr>
<tr>
<td>125</td>
<td>13.52</td>
<td>57.18</td>
<td>2.95</td>
<td>9.5</td>
</tr>
<tr>
<td>150</td>
<td>13.49</td>
<td>41.66</td>
<td>2.99</td>
<td>8.85</td>
</tr>
</tbody>
</table>
M₃ GENERATION

FIG. 32
Figure-32 shows the per cent variation in seed output and seed yield of the 3rd generation while Table-81 shows the CV value within population.

Reproductive Capacity:

The reproductive capacity was calculated for the control as well as for the different treated progenies. While control showing a value of 578.9, the gamma-ray treated progeny even at its lowest level showed 274.98. The value of reproductive capacity falls badly with the increasing intensity of doses. The lowest value for reproductive capacity in the present study (13.55) has been obtained under 125 krad treatment. When the same was calculated for 2nd generation the value showed a considerable improvement recording better values of reproductive capacity (Table-82). The data collected in the present study show that the reproductive capacity of a seed plant is highly affected by gamma-ray treatment.
Table - 82  Changes in the reproductive capacity of *Linum usitatissimum* L. var. Mukta after gamma-ray treatment in different generations.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Reproductive capacity</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M₁</td>
<td>M₂</td>
<td>M₃</td>
</tr>
<tr>
<td>Control</td>
<td>578.98</td>
<td>525.81</td>
<td>516.42</td>
</tr>
<tr>
<td>25</td>
<td>274.98</td>
<td>259.92</td>
<td>281.64</td>
</tr>
<tr>
<td>50</td>
<td>114.28</td>
<td>108.35</td>
<td>204.35</td>
</tr>
<tr>
<td>75</td>
<td>67.29</td>
<td>186.52</td>
<td>212.52</td>
</tr>
<tr>
<td>100</td>
<td>18.009</td>
<td>261.05</td>
<td>291.05</td>
</tr>
<tr>
<td>125</td>
<td>13.55</td>
<td>232.84</td>
<td>262.84</td>
</tr>
<tr>
<td>150</td>
<td>15.29</td>
<td>196.46</td>
<td>216.46</td>
</tr>
</tbody>
</table>
Variation:-

The morphological and anatomical variations caused by gamma-ray treatments in the different generations have been studied, using certain morphological, anatomical and floral characters as parameters.

The plants of $M_1$ generation of 25 krad treatment were all erect, while those of other treatments showed erect as well as lodged to semi-lodged habits. In higher doses like 100, 125 and 150 krad, the number of lodged and semi-lodged individuals were very high compared to lower doses (Plate-II). In the subsequent ($M_2$ and $M_3$) generations no lodging was noticed.

The shoot apices of the treated progeny in the $M_1$ generation showed various morphological modifications, the number of such abnormalities being proportionality high in higher doses. Among the anomalies noted, condensation of shoot apices, conversion of the apex into leaf-like bodies, apex getting twisted to take curvature or bending were noticed to be the most common ones (Plate-III & IV).

The shoot axis has often been noticed to bifurcate in the treated progenies especially in higher doses. Various other abnormalities in branching of the shoot axis have also been observed in the treated progenies. The branching has observed
to occur at any point on the shoot axis without showing any relationship to leaves (Plate-IVB). Branches have also developed in the internodal regions as well as from the hypocotyle of the plants. Such abnormal adventitious branches have been noticed to arise in large number in higher doses even at later stages of growth such as after flowering and fruit development. Such branches remained short and had borne narrow small leaves. In addition to the above a characteristic swelling occurred in the hypocotyle region which developed into a nodule later. The plants which showed such swelling generally showed lodging. In general such plants having such regions had become brittle which often led to breakage of the stem at the base.

Several abnormalities have been noted in the foliage leaf which ranged from reduced structure to trifurcate bodies (Plate-IIIC).

Occurrence of variegation happens to be another frequent abnormality in the \( M_1 \) generation of the different treatments. Total to partial variegation has been noted under different treatments of the \( M_1 \) generation. Most of the variegated plants did not survive and therefore, their subsequent generations could not be studied.

The phenomenon of fasciation was frequently met with in the different higher doses like 100, 125 and 150 krad treatments
it-'

(Plate-III A, B, D & Plate-IVA). No such phenomenon could be observed in control as well as in lower doses. In general, no abnormal structure of morphological nature was noted in the $M_2$ and $M_3$ generations irrespective of the intensity of the doses involved in the treatment.

Floral variation:-- A number of qualitative variations have been observed to occur in the floral parts. No quantitative analysis could be made of this variation as their occurrence did not follow any trend. Some of the observations are recorded below. The size of the pedicel has been found to be generally shorter in the treated progenies than in the control (Table-83).

The flowers showed abnormalities in having more number of sepals and petals than the normal number five. The size has also been noted to vary to a great extent in the abnormal flowers than in the normal types. Frequently fusion of several sepals and petals also has been observed in certain cases. All these abnormalities were of frequent occurrence in higher doses than in the lower ones.

The fasciated branches also showed flowering. The inflorescence developing on such branches were noted to be highly condensed and they behaved like verticillate or head like structures. The flower developing on such abnormal inflorescence showed
Table - 83  Changes in pedicel length of *Linum usitatissimum* L. var. Mukta after gamma-ray treatment in different generations.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Pedicel length in cm.</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M₁</td>
<td>M₂</td>
<td>M₃</td>
</tr>
<tr>
<td>Control</td>
<td>2.66 ±0.651</td>
<td>2.69 ±0.601</td>
<td>2.50 ±0.654</td>
</tr>
<tr>
<td>25</td>
<td>2.06* ±0.564</td>
<td>2.59 ±0.554</td>
<td>2.61 ±0.439</td>
</tr>
<tr>
<td>50</td>
<td>2.11* ±0.554</td>
<td>2.88 ±0.564</td>
<td>2.58 ±0.425</td>
</tr>
<tr>
<td>75</td>
<td>2.69 ±0.668</td>
<td>2.79 ±0.714</td>
<td>2.32 ±0.502</td>
</tr>
<tr>
<td>100</td>
<td>2.273* ±0.762</td>
<td>2.71 ±0.801</td>
<td>2.38 ±0.506</td>
</tr>
<tr>
<td>125</td>
<td>2.159* ±0.680</td>
<td>2.78 ±0.844</td>
<td>2.40 ±0.614</td>
</tr>
<tr>
<td>150</td>
<td>1.859* ±0.476</td>
<td>2.88 ±0.729</td>
<td>2.50 ±0.461</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>0.3214</td>
<td>0.3423</td>
<td>0.2621</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level.
partial to fully fused condition. In such a group of closely packed bunch of flowers, the identity of individual flowers often got lost and the resulting body appeared to be quite interesting. The seeds collected from such abnormal flowers did not give rise to the same condition, in the 2nd generation, although the seeds developed into full fledged plants and flowered.

**Pollen viability:** 98 to 100 per cent pollen were found to be viable and fertile in the control set of plants, while the treated progenies showed different degrees of male sterility. Figure-33 shows the position of pollen fertility under different treatments. The radiation treatment happens to be so damaging that even the lowest dose has caused serious damage to the pollen fertility. The fertility fell to the minimum of 2 per cent in the highest dose of 150 krad treatment.

The pollen fertility of 2nd and 3rd generations showed, as high a percentage, as that of control, indicating that the damage caused by the radiation treatment is not permanent (Figure-33). The radiation treatments have also been noticed to affect the fruit setting and seed development. A large percentage of flowers developed into abnormal fruits containing papery seeds. Such fruits remained small and shrivelled. Figure-34 shows the percentage of abnormal seeds set under the different treatments.
Figure 33

Pollen fertility in percentage

- $M_1$ GENERATION
- $M_2$ GENERATION
- $M_3$ GENERATION

DOSES IN KRAD

FIG. 33
ABNORMAL SEEDS ($M_1$ & $M_2$)
NORMAL SEEDS ($M_1$)
NORMAL SEEDS ($M_2$)
NORMAL SEEDS ($M_3$)

![Graph showing seed viability at different doses](image)

**Fig. 34**
Anatomical variations: A number of anatomical variations have been observed to develop in the shoot axis both in the ground tissue as well as in the vascular region. Some of the abnormalities have been studied quantitatively while many of them were recorded as mere qualitative variations as they were not of any quantitative nature.

Gross anatomy: The shoot axis of the different treatments in transectional view has shown that the ground tissue constituting the pith region and the cortex proliferate to give rise to wider pith and cortex in the treated progenies, while the xylem cylinder remains thinner than in the control. In all the treated progenies, the thickness of shoot axis happens to be significantly narrow compared to that of control under all treatments and at all height levels studied (Table-84). Table-85 gives the proportional area of cortex xylem and pith in the shoot axis at different height levels, under different treatments. The cortical region shows the increasing order of expansion from the hypocotyl region to the upper region of the plant in control as well as under the lower doses. At higher doses this increasing trend of cortical area from base to apex is getting disturbed but rather reversed under 100 and 150 krad treatment in which the cortical area in hypocotyl region has been noticed to be larger than at the higher levels of the shoot axis. The pith region showed a reversed trend to that
Table - 84  Transectional area ($\text{mm}^2$) of shoot axis of *Linum usitatissimum* L. var. Mukta at various height levels of plants of M1 generation under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Transectional area ($\text{mm}^2$) of shoot axis</th>
<th>Hypocotyle</th>
<th>Base</th>
<th>Middle</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>37.35</td>
<td>± 3.1374</td>
<td>21.97</td>
<td>± 1.7576</td>
</tr>
<tr>
<td>± 2.983</td>
<td></td>
<td>26.74</td>
<td>± 2.8344</td>
<td>18.40</td>
<td>± 1.8032</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>24.71</td>
<td>± 2.9652</td>
<td>17.40</td>
<td>± 2.02</td>
</tr>
<tr>
<td>± 2.983</td>
<td></td>
<td>21.80</td>
<td>± 2.834</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>22.00</td>
<td>± 3.52</td>
<td>14.41</td>
<td>± 2.4496</td>
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<td>± 3.884</td>
<td></td>
<td>17.41</td>
<td>± 2.8204</td>
<td></td>
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</tr>
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<td>75</td>
<td></td>
<td>19.42</td>
<td>± 3.884</td>
<td>12.73</td>
<td>± 2.5968</td>
</tr>
<tr>
<td>± 3.9054</td>
<td></td>
<td>15.69</td>
<td>± 3.0752</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>16.27</td>
<td>± 3.9054</td>
<td>8.72</td>
<td>± 2.4416</td>
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<tr>
<td>± 3.069</td>
<td></td>
<td>12.09</td>
<td>± 2.875</td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>10.23</td>
<td>± 3.069</td>
<td>7.50</td>
<td>± 2.43</td>
</tr>
<tr>
<td>± 3.069</td>
<td></td>
<td>8.66</td>
<td>± 2.978</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>2.2689</td>
<td>2.0089</td>
<td>1.8732</td>
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<tr>
<td>L.S.D. at 5% level</td>
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<td>2.2689</td>
<td>2.0089</td>
<td>1.8732</td>
<td></td>
</tr>
</tbody>
</table>

+ = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level
Table - 85 Proportional area (%) of Cortex, xylem cylinder and pith in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of *M*<sub>1</sub> generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Proportional Area in Percentage</th>
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<tbody>
<tr>
<td></td>
<td>Cortex</td>
<td>Xylem</td>
<td>Pith</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>17.28</td>
<td>82.53</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>27.27</td>
<td>71.67</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>25.34</td>
<td>67.25</td>
<td>7.39</td>
</tr>
<tr>
<td></td>
<td>U</td>
<td>26.29</td>
<td>53.44</td>
<td>20.18</td>
</tr>
<tr>
<td>25</td>
<td>H</td>
<td>25.84</td>
<td>74.01</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>27.31</td>
<td>71.60</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>33.34</td>
<td>49.44</td>
<td>17.20</td>
</tr>
<tr>
<td></td>
<td>U</td>
<td>38.96</td>
<td>35.29</td>
<td>25.74</td>
</tr>
<tr>
<td>50</td>
<td>H</td>
<td>31.90</td>
<td>67.96</td>
<td>0.11</td>
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<tr>
<td></td>
<td>B</td>
<td>31.50</td>
<td>65.38</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>37.89</td>
<td>43.37</td>
<td>18.72</td>
</tr>
<tr>
<td></td>
<td>U</td>
<td>34.23</td>
<td>36.90</td>
<td>28.86</td>
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<td>75</td>
<td>H</td>
<td>33.58</td>
<td>66.34</td>
<td>0.06</td>
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<tr>
<td></td>
<td>B</td>
<td>42.89</td>
<td>52.90</td>
<td>4.20</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>51.51</td>
<td>36.40</td>
<td>12.08</td>
</tr>
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<td></td>
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<td>59.64</td>
<td>27.53</td>
<td>12.81</td>
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<td>H</td>
<td>46.24</td>
<td>53.60</td>
<td>0.15</td>
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<td></td>
<td>B</td>
<td>30.84</td>
<td>68.12</td>
<td>1.03</td>
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<td>M</td>
<td>28.62</td>
<td>67.35</td>
<td>4.02</td>
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<td>42.53</td>
<td>38.61</td>
<td>18.85</td>
</tr>
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<td>43.24</td>
<td>52.39</td>
<td>4.35</td>
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<td></td>
<td>B</td>
<td>38.68</td>
<td>58.28</td>
<td>3.03</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>38.43</td>
<td>43.90</td>
<td>17.66</td>
</tr>
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<td>U</td>
<td>47.10</td>
<td>37.36</td>
<td>15.52</td>
</tr>
<tr>
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<td>H</td>
<td>52.89</td>
<td>46.31</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>40.89</td>
<td>55.50</td>
<td>3.60</td>
</tr>
<tr>
<td></td>
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<td>53.77</td>
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</tr>
<tr>
<td></td>
<td>U</td>
<td>44.10</td>
<td>42.08</td>
<td>13.81</td>
</tr>
</tbody>
</table>

H = Hypocotyle, B = Base, M = Middle, U = Upper
of cortex in having higher proportional area up the stem than at the base. This increase in pith proportion has been followed to follow the same trend under all treatments.

The area of xylem cylinder has been noticed to fall from base to apex in the shoot axis under all treatments including the control. Compared to that of control, the treated progenies showed thinning of xylem cylinder under all treatments, the degree of thinning being more under high doses than in the lower ones. Table-86 shows the shoot axis thickness in M₂ generation. Here also the treated progenies remained significantly thinner than that of control under all treatments. Table-87 gives the proportional area of cortex, xylem and pith at different height levels of the M₂ progenies. The trend exhibited by cortex has been noticed to be the same as in control under all treatments. The pith region also followed the same trend as that of control, although it showed a larger proportion under higher doses. The area of xylem cylinder showed a partial recovery in the 2nd generation and followed the same trend as in the control.

Table-88 shows the thickness of the stem at different height levels of the plants in the 3rd generation. All the treated progeny except that of 25 krad showed 'significantly narrow stem compared to that of the control. In 25 krad treatment the base and apex had significantly lesser thickness compared to control while the hypocotyle and the middle region did not differ to any significant extent in the thickness to that of control.
Table - 86 Transectional area (mm²) of shoot axis of Linum usitatissimum L. var. Mukta at various height levels of plants of M₂ generation under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Transectional area (mm²) of shoot axis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypocotyle</td>
<td>Base</td>
</tr>
<tr>
<td>Control</td>
<td>36.61 ± 3.7342</td>
<td>31.82 ± 3.0546</td>
</tr>
<tr>
<td>25</td>
<td>32.06* ± 3.5264</td>
<td>11.35* ± 1.203</td>
</tr>
<tr>
<td>50</td>
<td>23.69* ± 2.8428</td>
<td>9.22* ± 1.1616</td>
</tr>
<tr>
<td>75</td>
<td>26.06* ± 3.1792</td>
<td>10.33* ± 1.2396</td>
</tr>
<tr>
<td>100</td>
<td>24.91* ± 3.786</td>
<td>10.77* ± 1.5724</td>
</tr>
<tr>
<td>125</td>
<td>25.25* ± 4.2924</td>
<td>12.10* ± 1.9602</td>
</tr>
<tr>
<td>150</td>
<td>30.81* ± 5.7306</td>
<td>13.79* ± 2.3718</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>2.8702</td>
<td>1.2058</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level
Table - 87 Proportional area (%) of Cortex, Xylem cylinder and Pith in the shoot axis of *Linum usitatissimum* L. var Mukta at different height levels of plants of M₂ generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Proportional Area in Percentage</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cortex</td>
<td>Xylem</td>
<td>Pith</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>16.46</td>
<td>83.35</td>
<td>0.19</td>
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<tr>
<td>B</td>
<td>27.32</td>
<td>70.56</td>
<td>2.12</td>
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<tr>
<td>M</td>
<td>26.79</td>
<td>64.25</td>
<td>8.96</td>
</tr>
<tr>
<td>U</td>
<td>29.41</td>
<td>48.62</td>
<td>21.97</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>12.89</td>
<td>86.86</td>
<td>0.24</td>
</tr>
<tr>
<td>B</td>
<td>27.31</td>
<td>70.38</td>
<td>2.29</td>
</tr>
<tr>
<td>M</td>
<td>32.23</td>
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<tr>
<td>M</td>
<td>30.37</td>
<td>47.66</td>
<td>21.96</td>
</tr>
<tr>
<td>U</td>
<td>35.49</td>
<td>30.51</td>
<td>33.99</td>
</tr>
<tr>
<td>75</td>
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<tr>
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<td>M</td>
<td>33.46</td>
<td>44.14</td>
<td>22.39</td>
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<td>U</td>
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<td>U</td>
<td>24.82</td>
<td>48.20</td>
<td>26.97</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>21.15</td>
<td>78.82</td>
<td>0.013</td>
</tr>
<tr>
<td>B</td>
<td>28.65</td>
<td>69.41</td>
<td>1.93</td>
</tr>
<tr>
<td>M</td>
<td>28.24</td>
<td>54.23</td>
<td>17.52</td>
</tr>
<tr>
<td>U</td>
<td>33.20</td>
<td>48.70</td>
<td>18.08</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>19.75</td>
<td>80.15</td>
<td>0.09</td>
</tr>
<tr>
<td>B</td>
<td>25.17</td>
<td>73.55</td>
<td>1.275</td>
</tr>
<tr>
<td>M</td>
<td>26.95</td>
<td>60.15</td>
<td>12.89</td>
</tr>
<tr>
<td>U</td>
<td>27.66</td>
<td>45.83</td>
<td>26.49</td>
</tr>
</tbody>
</table>

H = Hypocotyle,  B = Base,  M = Middle,  U = Upper
Table-89 shows the proportional area of cortex, xylem and pith in the different progenies of the $M_3$ generation. A glance at the data provided indicates that the xylem cylinder has recovered fully from the thinning effect of irradiation in the 3rd generation.

**Cortex:** The perivascular fibres which are of economic importance have been noticed to increase in the treated progenies compared to that of control. Plate-V shows the amount of cortical fibre in the different treatments.

**Xylem anatomy:** In addition to the thinning effect of xylem, various other abnormalities have also been noticed in the xylem anatomy of the different progenies (Plate-VI & VII). Under high doses, the development of xylem tissue is disturbed to various degrees. In general the vessel frequency appears to decrease under the influence of gamma-ray treatments (Plate-VIII), while the ray cells give rise to wider rays (Plate-IX & X) and consequently the proportion of radial system in xylem increases with the increasing dose. Figure-35 shows the relative percentage of radial and axial system in wood of the variety studied, under different treatments. It becomes obvious that the ray proportion multiplies to a number of times in the treated progenies compared to control. In the present investigation the maximum amount of ray tissue has been noticed in 100 krad treatment (Plate-IXD). In $M_2$ generation the amount of
Table - 88  Transectional area (mm²) of shoot axis of *Linum usitatissimum* L. var. Mukta at various height levels of plants of M³ generation under different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Hypocotyle (mm²)</th>
<th>Base (mm²)</th>
<th>Middle (mm²)</th>
<th>Upper (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>35.41 ± 3.6118</td>
<td>31.79 ± 2.8611</td>
<td>18.76 ± 1.7634</td>
<td>13.64 ± 1.3094</td>
</tr>
<tr>
<td>25</td>
<td>33.11 ± 3.3441</td>
<td>27.44* ± 2.6068</td>
<td>17.54* ± 1.7189</td>
<td>12.51* ± 1.251</td>
</tr>
<tr>
<td>50</td>
<td>29.86* ± 3.1950</td>
<td>19.63* ± 2.0415</td>
<td>15.96* ± 1.7556</td>
<td>10.32* ± 1.0939</td>
</tr>
<tr>
<td>75</td>
<td>28.53* ± 2.9671</td>
<td>18.88* ± 2.0201</td>
<td>14.99* ± 1.5739</td>
<td>9.87* ± 1.0166</td>
</tr>
<tr>
<td>100</td>
<td>29.24* ± 3.1871</td>
<td>21.59* ± 2.3749</td>
<td>15.18* ± 1.6242</td>
<td>9.59* ± 1.0549</td>
</tr>
<tr>
<td>150</td>
<td>30.76* ± 3.5681</td>
<td>20.95* ± 2.3464</td>
<td>14.55* ± 1.6878</td>
<td>10.87* ± 1.3044</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>2.3461</td>
<td>1.9856</td>
<td>1.2825</td>
<td>0.9516</td>
</tr>
</tbody>
</table>

† = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level
Table - 89 Proportional area (%) of Cortex, Xylem cylinder and Pith in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of *M*₃ generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Proportional Area in Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cortex</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>18.31</td>
</tr>
<tr>
<td>B</td>
<td>28.05</td>
</tr>
<tr>
<td>M</td>
<td>29.63</td>
</tr>
<tr>
<td>U</td>
<td>31.47</td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>13.23</td>
</tr>
<tr>
<td>B</td>
<td>25.62</td>
</tr>
<tr>
<td>M</td>
<td>30.80</td>
</tr>
<tr>
<td>U</td>
<td>33.58</td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>19.17</td>
</tr>
<tr>
<td>B</td>
<td>32.14</td>
</tr>
<tr>
<td>M</td>
<td>33.12</td>
</tr>
<tr>
<td>U</td>
<td>36.17</td>
</tr>
<tr>
<td>75</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>20.63</td>
</tr>
<tr>
<td>B</td>
<td>30.36</td>
</tr>
<tr>
<td>M</td>
<td>32.40</td>
</tr>
<tr>
<td>U</td>
<td>34.19</td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>17.24</td>
</tr>
<tr>
<td>B</td>
<td>26.66</td>
</tr>
<tr>
<td>M</td>
<td>31.70</td>
</tr>
<tr>
<td>U</td>
<td>35.00</td>
</tr>
<tr>
<td>125</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>19.00</td>
</tr>
<tr>
<td>B</td>
<td>29.26</td>
</tr>
<tr>
<td>M</td>
<td>29.91</td>
</tr>
<tr>
<td>U</td>
<td>31.02</td>
</tr>
<tr>
<td>150</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>19.23</td>
</tr>
<tr>
<td>B</td>
<td>27.83</td>
</tr>
<tr>
<td>M</td>
<td>28.01</td>
</tr>
<tr>
<td>U</td>
<td>27.29</td>
</tr>
</tbody>
</table>

H = Hypocotyle, B = Base, M = Middle, U = Upper
FIG. 35
radial system surprisingly goes down to the extent that it forms far below a level compared to that of the control (Figure-35). In $M_3$ generation also the radial system remains in its proportion below the level of control, although it is a little higher than the $M_2$ generation in a few cases. On the whole, the axial system develops to a greater extent in $M_3$ generation than in the $M_1$ generation under all treatments (Plate-XI).

As a result of gamma-ray irradiation, the heterogenous ray system tends to become homogenous in having only upright cells (Plate-XII). In general the ray cells tend to become vertically polarized as axial elements. In tangential view the ray cells appear almost like fusiform cells in such cases (Plate-XC).

In response to irradiation, the vessel elements develop thick gelatinous walls and reduced lumen (Plate-VIII). In addition to the structural changes, the vessel elements grow shorter and narrower than in control in a direct relationship to that of the intensity of gamma ray dose. The wall of all types of tracheary elements and the ray cells grow thicker and get lignified. Even the ray cells develop quite a conspicuous thickened wall impregnated with lignin (Plate VIII & X).

The quantitative analysis of tracheary elements with regard to their dimension, has revealed that the length and width averages undergo reduction under irradiated condition. Table-90 shows the
vessel length in the different treated progenies at different height levels in \( M_1 \) generation. Vessel length is significantly shorter than in control in the basal region under 150 krad treatment, while in lower doses it is higher than in control. In the middle region of the stem under 50, 75 and 100 krad treatments, the mean length of vessels was found to be higher than in control, while under 150 treatment, it was found to be significantly short. In the upper region, on the other hand, no difference in mean length of vessels has been observed under the different treatments. Table-91 gives the picture of vessel diameter in the different regions of the plant under different treatments. The mean width under all treatments at all levels of height significantly differ from that of control, except under 25 krad treatment in which the mean width of vessels in the middle region showed a marginal increase over that of control but to an insignificant level. Similarly pore size has also been found to be reduced in size under all treatments except the 25 krad treatment (Table-92).

Table-93 gives the data collected on fibre length. Here the basal region appears to be more affected than the other regions. At the upper region of plants, the length average was found to follow closely the control except in 25 krad treatment, while the middle region showed a higher variation in the first four treatments (Table-93).
Table - 90  Changes in vessel length average in the shoot axis of Linum usitatissimum L. var. Mukta at different height levels of plants of M<sub>1</sub> generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean vessel length (mµ) in shoot axis</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
<td>Middle</td>
<td>Upper</td>
<td>Grand Mean</td>
</tr>
<tr>
<td>Control</td>
<td>299 ± 36.48</td>
<td>371 ± 65.50</td>
<td>450 ± 59.79</td>
<td>373 ± 55.92</td>
</tr>
<tr>
<td></td>
<td>(233-378)</td>
<td>(287-482)</td>
<td>(342-585)</td>
<td>(233-585)</td>
</tr>
<tr>
<td>25</td>
<td>358* ± 94.81</td>
<td>375 ± 96.31</td>
<td>421 ± 92.28</td>
<td>384 ± 94.46</td>
</tr>
<tr>
<td></td>
<td>(200-562)</td>
<td>(175-506)</td>
<td>(175-662)</td>
<td>(125-662)</td>
</tr>
<tr>
<td>50</td>
<td>370* ± 100.11</td>
<td>431* ± 129.62</td>
<td>436 ± 92.68</td>
<td>412* ± 107.47*</td>
</tr>
<tr>
<td></td>
<td>(200-575)</td>
<td>(175-687)</td>
<td>(162-625)</td>
<td>(162-687)</td>
</tr>
<tr>
<td>75</td>
<td>374* ± 86.16</td>
<td>436* ± 82.95</td>
<td>468* ± 129.87</td>
<td>426* ± 99.66</td>
</tr>
<tr>
<td></td>
<td>(200-537)</td>
<td>(262-600)</td>
<td>(268-731)</td>
<td>(200-731)</td>
</tr>
<tr>
<td>100</td>
<td>275 ± 80.42</td>
<td>435* ± 81.12</td>
<td>431 ± 101.25</td>
<td>380 ± 87.59</td>
</tr>
<tr>
<td></td>
<td>(75-437)</td>
<td>(262-600)</td>
<td>(150-625)</td>
<td>(75-625)</td>
</tr>
<tr>
<td>125</td>
<td>281 ± 91.50</td>
<td>349 ± 88.27</td>
<td>416 ± 107.65</td>
<td>364 ± 95.80</td>
</tr>
<tr>
<td></td>
<td>(87-475)</td>
<td>(137-550)</td>
<td>(250-600)</td>
<td>( 87-600)</td>
</tr>
<tr>
<td>150</td>
<td>242* ± 86.83</td>
<td>294* ± 82.02</td>
<td>436 ± 116.90</td>
<td>324* ± 95.25</td>
</tr>
<tr>
<td></td>
<td>(62-387)</td>
<td>(150-475)</td>
<td>(200-625)</td>
<td>( 62-625)</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>26.1929</td>
<td>36.2161</td>
<td>39.9029</td>
<td>34.1038</td>
</tr>
</tbody>
</table>

± = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level
Within Parenthesis - Range.
Table - 91 Changes in mean diameter of vessels in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of M₁ generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean diameter (µm) of vessels in shoot axis</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
<td>Middle</td>
<td>Upper</td>
<td>Grand Mean</td>
</tr>
<tr>
<td>Control</td>
<td>± 5.06</td>
<td>± 2.50</td>
<td>± 2.05</td>
<td>± 3.20</td>
</tr>
<tr>
<td>25</td>
<td>± 5.50</td>
<td>± 8.67</td>
<td>± 5.07</td>
<td>± 6.41</td>
</tr>
<tr>
<td></td>
<td>(18-37)</td>
<td>(18-50)</td>
<td>(12-37)</td>
<td>(12-50)</td>
</tr>
<tr>
<td>50</td>
<td>± 6.55</td>
<td>± 7.92</td>
<td>± 3.60</td>
<td>± 6.02</td>
</tr>
<tr>
<td></td>
<td>(12-37)</td>
<td>(18-31)</td>
<td>(12-37)</td>
<td>(12-43)</td>
</tr>
<tr>
<td>75</td>
<td>± 11.37</td>
<td>± 3.95</td>
<td>± 6.07</td>
<td>± 7.13</td>
</tr>
<tr>
<td></td>
<td>(18-37)</td>
<td>(12-37)</td>
<td>(12-37)</td>
<td>(12-37)</td>
</tr>
<tr>
<td>100</td>
<td>± 5.77</td>
<td>± 3.89</td>
<td>± 3.95</td>
<td>± 4.54</td>
</tr>
<tr>
<td></td>
<td>(12-37)</td>
<td>(12-37)</td>
<td>(12-37)</td>
<td>(12-37)</td>
</tr>
<tr>
<td>125</td>
<td>± 5.90</td>
<td>± 3.65</td>
<td>± 4.31</td>
<td>± 4.62</td>
</tr>
<tr>
<td></td>
<td>(12-37)</td>
<td>(12-31)</td>
<td>(12-31)</td>
<td>(12-37)</td>
</tr>
<tr>
<td>150</td>
<td>± 5.77</td>
<td>± 5.42</td>
<td>± 4.98</td>
<td>± 5.37</td>
</tr>
<tr>
<td></td>
<td>(12-37)</td>
<td>(12-25)</td>
<td>(12-25)</td>
<td>(12-37)</td>
</tr>
<tr>
<td>L.S.D.</td>
<td>3.9110</td>
<td>3.0421</td>
<td>2.3849</td>
<td>3.2468</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level  
within Parenthesis - Range
Table - 92  Changes in pore size of vessels in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of M₁ generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Vessel pore size (μm) in shoot axis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
</tr>
<tr>
<td>Control</td>
<td>18.3 ± 2.45</td>
</tr>
<tr>
<td></td>
<td>(13-22)</td>
</tr>
<tr>
<td>25</td>
<td>16.0* ± 4.64</td>
</tr>
<tr>
<td>50</td>
<td>12.6* ± 3.05</td>
</tr>
<tr>
<td></td>
<td>(6-18)</td>
</tr>
<tr>
<td>75</td>
<td>12.6* ± 5.32</td>
</tr>
<tr>
<td></td>
<td>(6-25)</td>
</tr>
<tr>
<td>100</td>
<td>13.1* ± 3.74</td>
</tr>
<tr>
<td></td>
<td>(6-18)</td>
</tr>
<tr>
<td>125</td>
<td>14.4* ± 3.65</td>
</tr>
<tr>
<td></td>
<td>(6-25)</td>
</tr>
<tr>
<td>150</td>
<td>11.8* ± 3.60</td>
</tr>
<tr>
<td></td>
<td>(6-18)</td>
</tr>
</tbody>
</table>

L.S.D. at 5% level 2.254 2.7264 2.4402 2.5467

* = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level within Parenthesis - Range
<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean fibre length (μm) in shoot axis</th>
<th>Base</th>
<th>Middle</th>
<th>Upper</th>
<th>Grand Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>412 ± 39.63 (343-470)</td>
<td>400</td>
<td>± 57.67 (312-493)</td>
<td>515 ± 62.20 (436-642)</td>
<td>± 53.16 (312-642)</td>
</tr>
<tr>
<td>25</td>
<td>457* ± 136.65 (225-800)</td>
<td>500*</td>
<td>± 142.37 (237-862)</td>
<td>511</td>
<td>± 124.28 (337-662)</td>
</tr>
<tr>
<td>75</td>
<td>430 ± 93.16 (200-625)</td>
<td>± 98.35 (193-612)</td>
<td>533</td>
<td>± 108.54 (262-887)</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>350* ± 66.95 (187-562)</td>
<td>500*</td>
<td>± 73.46 (375-600)</td>
<td>493</td>
<td>± 72.72 (312-650)</td>
</tr>
<tr>
<td>125</td>
<td>377* ± 76.75 (231-525)</td>
<td>405</td>
<td>± 71.7 (250-262)</td>
<td>516</td>
<td>± 82.57 (325-712)</td>
</tr>
<tr>
<td>150</td>
<td>328* ± 62.93 (212-425)</td>
<td>388</td>
<td>± 86.0 (187-587)</td>
<td>507</td>
<td>± 87.10 (275-737)</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>32.585</td>
<td>31.082</td>
<td>38.0266</td>
<td>33.897</td>
<td></td>
</tr>
</tbody>
</table>

± = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level
within Parenthesis - Range

Table - 93 Changes in length average of xylem fibres in the shoot axis of Linum usitatissimum L. var Mukta at different height levels of plants of M<sub>1</sub> generation treated with different gamma-ray doses.
Table - 94  Changes in width average of xylem fibres in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of *M*₁ generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean fibre width (μm) in shoot axis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18.7</td>
</tr>
<tr>
<td></td>
<td>± 2.02</td>
</tr>
<tr>
<td></td>
<td>(15-21)</td>
</tr>
<tr>
<td>25</td>
<td>18.1</td>
</tr>
<tr>
<td></td>
<td>± 4.85</td>
</tr>
<tr>
<td>50</td>
<td>15.2*</td>
</tr>
<tr>
<td></td>
<td>± 3.55</td>
</tr>
<tr>
<td>75</td>
<td>15.6*</td>
</tr>
<tr>
<td></td>
<td>± 3.66</td>
</tr>
<tr>
<td>100</td>
<td>15.1*</td>
</tr>
<tr>
<td></td>
<td>± 3.32</td>
</tr>
<tr>
<td>125</td>
<td>15.0*</td>
</tr>
<tr>
<td></td>
<td>± 3.76</td>
</tr>
<tr>
<td>150</td>
<td>16.8*</td>
</tr>
<tr>
<td></td>
<td>± 4.58</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>1.8001</td>
</tr>
</tbody>
</table>

± = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level within Parenthesis - Range
The fibre width in the basal region showed a significant reduction under all treatments excepting 25 krad dose. In the middle and upper regions, the fibre width did not differ under different treatments (Table-94). When the fibre width is compared in the plant as a whole, no significant difference has been found in the treated as well as in the untreated plants (Table-94). In \( M_2 \) generation the vessel length differed to a significant level under the different treatments from that of control. It is more so in the basal region than in the middle and upper regions. This appears to be due to the recovery that the plants had undergone during the 2nd generation (Table-95). The vessel width on the other hand shows a greater variation under different treatments than the mean length. It is significantly lesser in basal region under all treatments, but in the middle and upper regions, it has only been found to be narrow in higher doses (Table-96). The pore size showed a significant difference, only under 125 and 150 krad treatments. In the upper region, it did not differ from that of control. When it is compared in the whole plant, no significant difference could be visible (Table-97).

Table-98 gives the length average of xylem fibre under different treatments in the \( M_2 \) generation. In the middle region the variation was exhibited under all treatments than in the basal and upper regions. The fibre length average recorded an increase over that of control in the majority of cases (Table-98).
Table - 95  Changes in vessel length average in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of *M2* generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean vessel length (μm) in shoot axis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
</tr>
<tr>
<td>Control</td>
<td>363 ± 45.55</td>
</tr>
<tr>
<td></td>
<td>(230-452)</td>
</tr>
<tr>
<td>25</td>
<td>415* ± 110.08</td>
</tr>
<tr>
<td></td>
<td>(187-675)</td>
</tr>
<tr>
<td>50</td>
<td>393 ± 86.26</td>
</tr>
<tr>
<td></td>
<td>(225-425)</td>
</tr>
<tr>
<td>75</td>
<td>322* ± 60.55</td>
</tr>
<tr>
<td></td>
<td>(212-462)</td>
</tr>
<tr>
<td>100</td>
<td>314* ± 53.91</td>
</tr>
<tr>
<td></td>
<td>(187-425)</td>
</tr>
<tr>
<td>125</td>
<td>320* ± 63.53</td>
</tr>
<tr>
<td></td>
<td>(212-437)</td>
</tr>
<tr>
<td>150</td>
<td>305* ± 69.40</td>
</tr>
<tr>
<td></td>
<td>(187-450)</td>
</tr>
<tr>
<td>L.S.D. at 5% Level</td>
<td>35.4218</td>
</tr>
</tbody>
</table>

† = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level  
Range within Parenthesis
Table - 96  Changes in mean diameter of vessels in the shoot axis of *Linum usitatissimum* L. var. *Mukta* at different height levels of plants of *Mg* generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean diameter of vessels (μm) in shoot axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>40.1 ± 4.75 (33-45) 35.3 ± 5.61 (30-45) 35.4 ± 1.51 (33-37) 36.9 ± 3.95 (30-45)</td>
</tr>
<tr>
<td>25</td>
<td>31.8* ± 6.43 (18-37) 35.2 ± 4.42 (25-37) 34.8 ± 5.18 (12-25) 33.9 ± 5.34 (12-37)</td>
</tr>
<tr>
<td>50</td>
<td>30.2* ± 5.72 (25-53) 36.9 ± 5.27 (25-50) 36.4 ± 6.53 (25-50) 34.5 ± 5.84 (12-37)</td>
</tr>
<tr>
<td>75</td>
<td>31.6* ± 6.75 (25-43) 34.6 ± 4.79 (25-37) 32.8* ± 5.20 (25-37) 33.0* ± 5.58 (25-43)</td>
</tr>
<tr>
<td>100</td>
<td>24.8 ± 1.73 (18-31) 33.8 ± 5.98 (25-50) 33.1 ± 5.95 (25-43) 30.6* ± 4.55 (18-50)</td>
</tr>
<tr>
<td>125</td>
<td>25.6* ± 3.36 (18-37) 23.9* ± 2.36 (18-25) 27.7* ± 6.28 (18-37) 24.7* ± 4.00 (18-25)</td>
</tr>
<tr>
<td>150</td>
<td>29.2* ± 7.13 (12-50) 29.2* ± 8.75 (25-50) 24.3* ± 3.29 (12-31) 27.6* ± 6.39 (12-62)</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>3.1245 3.014 2.4987 3.1254</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level  
within Parenthesis - Range
Table - 97  Changes in pore size of vessels in the shoot axis of Linum usitatissimum L. var. Mukta at different height levels of plants of M₀ generation with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Vessel pore size (µ) in shoot axis</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
<td>Middle</td>
<td>Upper</td>
<td>Grand Mean</td>
</tr>
<tr>
<td>Control</td>
<td>21.4 ± 2.15</td>
<td>21.4 ± 2.42</td>
<td>24.2 ± 1.11</td>
<td>22.3 ± 1.89</td>
</tr>
<tr>
<td></td>
<td>(18-23)</td>
<td>(17-23)</td>
<td>(22-25)</td>
<td>(17-25)</td>
</tr>
<tr>
<td>25</td>
<td>22.9 ± 4.58</td>
<td>24.3* ± 2.55</td>
<td>24.3 ± 2.00</td>
<td>23.8 ± 3.04</td>
</tr>
<tr>
<td>50</td>
<td>21.6 ± 4.33</td>
<td>23.4 ± 3.93</td>
<td>26.5 ± 3.01</td>
<td>23.8 ± 3.75</td>
</tr>
<tr>
<td>75</td>
<td>22.0 ± 4.98</td>
<td>25.0* ± 4.34</td>
<td>26.1 ± 7.41</td>
<td>24.3 ± 5.57</td>
</tr>
<tr>
<td></td>
<td>(12-25)</td>
<td>(12-25)</td>
<td>(12-37)</td>
<td>(12-37)</td>
</tr>
<tr>
<td>100</td>
<td>23.0 ± 4.05</td>
<td>22.0 ± 3.86</td>
<td>23.5 ± 3.15</td>
<td>22.8 ± 3.68</td>
</tr>
<tr>
<td>125</td>
<td>25.0* ± 3.30</td>
<td>24.4* ± 2.29</td>
<td>22.5 ± 5.08</td>
<td>23.9 ± 3.56</td>
</tr>
<tr>
<td></td>
<td>(12-37)</td>
<td>(12-25)</td>
<td>(12-25)</td>
<td>(12-37)</td>
</tr>
<tr>
<td>150</td>
<td>21.2 ± 5.63</td>
<td>24.3* ± 3.29</td>
<td>22.6 ± 4.87</td>
<td>22.7 ± 4.59</td>
</tr>
<tr>
<td></td>
<td>(12-37)</td>
<td>(12-31)</td>
<td>(12-25)</td>
<td>(12-37)</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>3.0189</td>
<td>2.0664</td>
<td>2.6789</td>
<td>2.5981</td>
</tr>
</tbody>
</table>

± = Standard deviation  
L.S.D. = Least significant difference  
* = Significant at 5% level within Parenthesis - Range
Table - 98  Changes in length average of xylem fibres in the shoot axis of Linum usitatissimum L. var. Mukta at different height levels of plants of M₂ generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean fibre length (μm) in shoot axis</th>
<th>Base</th>
<th>Middle</th>
<th>Upper</th>
<th>Grand Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>343 ±57.86</td>
<td>369 ±41.57</td>
<td>369 ±90.31</td>
<td>369 ±63.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(252-422)</td>
<td>(310-407)</td>
<td>(390-418)</td>
<td>(252-422)</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>421* ±45.72</td>
<td>484* ±62.66</td>
<td>492* ±57.10</td>
<td>466* ±71.82</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(237-550)</td>
<td>(350-600)</td>
<td>(400-600)</td>
<td>(237-600)</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>348 ±85.67</td>
<td>492* ±74.93</td>
<td>426* ±60.02</td>
<td>422* ±73.54</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(212-475)</td>
<td>(375-650)</td>
<td>(337-537)</td>
<td>(212-650)</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>391* ±65.31</td>
<td>451* ±91.22</td>
<td>532* ±135.53</td>
<td>458* ±97.35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(237-525)</td>
<td>(250-587)</td>
<td>(275-787)</td>
<td>(237-787)</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>315 ±74.63</td>
<td>427* ±74.10</td>
<td>404 ±65.05</td>
<td>382 ±71.26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(225-437)</td>
<td>(312-562)</td>
<td>(312-525)</td>
<td>(225-562)</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>375 ±76.8</td>
<td>316* ±72.27</td>
<td>379 ±89.07</td>
<td>357 ±79.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(325-712)</td>
<td>(225-525)</td>
<td>(200-500)</td>
<td>(200-712)</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>318 ±73.28</td>
<td>469* ±68.36</td>
<td>367 ±97.45</td>
<td>385 ±79.69</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(187-487)</td>
<td>(337-612)</td>
<td>(187-600)</td>
<td>(187-612)</td>
</tr>
<tr>
<td>L.S.D. at 5%</td>
<td>35.6614</td>
<td>32.8712</td>
<td>40.1130</td>
<td>36.6104</td>
<td></td>
</tr>
</tbody>
</table>

* = Significant at 5% level within Parenthesis - Range
= Least significant difference
= Standard deviation
Table - 99  Changes in width average of xylem fibres in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of M2 generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean fibre width (μm) in shoot axis</th>
<th>Base</th>
<th>Middle</th>
<th>Upper</th>
<th>Grand Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>23.6±1.42</td>
<td>21.3±1.68</td>
<td>16.5±1.85</td>
<td>20.4±1.65</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>(22-26)</td>
<td>(18-23)</td>
<td>(13-36)</td>
<td>(13-36)</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>14.1±3.50</td>
<td>16.6±4.73</td>
<td>22.6±3.08</td>
<td>17.8±3.77</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>12.7±1.12</td>
<td>18.9±4.95</td>
<td>17.3±5.41</td>
<td>16.3±3.83</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>14.0±3.10</td>
<td>13.6±2.76</td>
<td>13.6±3.13</td>
<td>13.7±2.49</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>14.6±3.80</td>
<td>12.5±2.86</td>
<td>12.9±1.61</td>
<td>13.3±2.75</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>12.8±2.20</td>
<td>14.5±3.42</td>
<td>13.8±4.28</td>
<td>13.7±3.30</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>19.0±5.31</td>
<td>20.5±5.30</td>
<td>12.5±1.42</td>
<td>17.3±4.01</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td></td>
<td>1.9071</td>
<td>2.5174</td>
<td>1.8842</td>
<td>2.0431</td>
</tr>
</tbody>
</table>

* = Significant at 5% level within Parenthesis - Range

+= Standard deviation

L.S.D. = Least significant difference
Table-99 gives the data collected on fibre width in the M2 generation. There is a significant decrease in fibre width average under all treatments except in a few cases in the middle and upper regions. When the comparison is made in the plant as a whole, the difference in fibre width has become significantly evident under all treatments.

Table-100, 101, 102, 103 and 104 show the size average of vessels and fibres under different treatments in the M3 generation. Statistical analysis of the data does not indicate any difference between treated and untreated progenies in any of the parameters studied except in a few cases like that of fibre length and width in 50 and 150 krad treatment (Tables-103 & 104).
Table - 100 Changes in vessel length average in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of *M*₃ generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean vessel length (μm) in shoot axis</th>
<th>Base</th>
<th>Middle</th>
<th>Upper</th>
<th>Grand Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>350</td>
<td>+46.71</td>
<td>380</td>
<td>+60.72</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>380</td>
<td>+90.66</td>
<td>399</td>
<td>+70.44</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>345</td>
<td>+80.41</td>
<td>402</td>
<td>+85.99</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>320</td>
<td>+85.00</td>
<td>375</td>
<td>+90.88</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>342</td>
<td>+75.66</td>
<td>395</td>
<td>+84.16</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>336</td>
<td>+90.72</td>
<td>380</td>
<td>+80.32</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>340</td>
<td>+86.36</td>
<td>375</td>
<td>+90.86</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td></td>
<td>35.6154</td>
<td>38.6172</td>
<td>42.4213</td>
<td>38.8846</td>
</tr>
</tbody>
</table>

+ = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level within Parenthesis - Range
Table - 101 Changes in mean diameter of vessels in the shoot axis of Linum usitatissimum L. var. Mukta at different height levels of plants of M₃ generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean Diameter of Vessels (μm) in shoot axis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
</tr>
<tr>
<td>Control</td>
<td>36.7</td>
</tr>
<tr>
<td></td>
<td>± 5.07</td>
</tr>
<tr>
<td>25</td>
<td>34.0</td>
</tr>
<tr>
<td></td>
<td>± 6.12</td>
</tr>
<tr>
<td>50</td>
<td>35.4</td>
</tr>
<tr>
<td></td>
<td>± 4.97</td>
</tr>
<tr>
<td>(20-45)</td>
<td>(20-38)</td>
</tr>
<tr>
<td>75</td>
<td>33.8</td>
</tr>
<tr>
<td></td>
<td>± 5.64</td>
</tr>
<tr>
<td>(28-48)</td>
<td>(20-40)</td>
</tr>
<tr>
<td>100</td>
<td>34.6</td>
</tr>
<tr>
<td></td>
<td>± 7.23</td>
</tr>
<tr>
<td>(20-50)</td>
<td>(15-42)</td>
</tr>
<tr>
<td>125</td>
<td>32.9</td>
</tr>
<tr>
<td></td>
<td>± 6.54</td>
</tr>
<tr>
<td>(25-45)</td>
<td>(15-45)</td>
</tr>
<tr>
<td>150</td>
<td>33.5</td>
</tr>
<tr>
<td></td>
<td>± 5.83</td>
</tr>
<tr>
<td>(20-42)</td>
<td>(15-50)</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>4.1257</td>
</tr>
</tbody>
</table>

± = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level
within Parenthesis = Range
Table - 102 Changes in pore size of vessels in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of M<sub>3</sub> generation treated with different gamma-ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Vessel Pore Size (mμ) in shoot axis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
<td>Middle</td>
</tr>
<tr>
<td>Control</td>
<td>20.4 ± 2.56</td>
<td>21.5 ± 2.34</td>
</tr>
<tr>
<td>25</td>
<td>19.2 ± 4.67</td>
<td>20.8 ± 4.21</td>
</tr>
<tr>
<td>50</td>
<td>18.8 ± 4.33</td>
<td>22.7 ± 3.86</td>
</tr>
<tr>
<td>75</td>
<td>20.0 ± 5.11</td>
<td>23.4 ± 4.75</td>
</tr>
<tr>
<td>100</td>
<td>19.5 ± 3.78</td>
<td>21.7 ± 3.34</td>
</tr>
<tr>
<td>125</td>
<td>18.4 ± 4.44</td>
<td>20.1 ± 4.67</td>
</tr>
<tr>
<td></td>
<td>(15-23)</td>
<td>(12-30)</td>
</tr>
<tr>
<td>150</td>
<td>20.2 ± 5.63</td>
<td>23.6 ± 4.02</td>
</tr>
<tr>
<td>L.S.D. at 5% level</td>
<td>3.0441</td>
<td>2.4671</td>
</tr>
</tbody>
</table>

* = Significant at 5% level

within Parenthesis - Rane

+ = Standard deviation

L.S.D. = Least significant difference
Table - 103  Changes in length average of xylem fibre in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of *M*₂ generation treated with different gamma ray doses.

<table>
<thead>
<tr>
<th>Doses in Krad</th>
<th>Mean Fibre Length (m) in shoot axis</th>
<th>Base</th>
<th>Middle</th>
<th>Upper</th>
<th>Grand Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>390</td>
<td>409</td>
<td>440</td>
<td>413</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±55.86</td>
<td>±65.32</td>
<td>±62.46</td>
<td>±61.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(260-450)</td>
<td>(315-490)</td>
<td>(350-500)</td>
<td>(260-500)</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>395</td>
<td>415</td>
<td>455</td>
<td>422</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±75.42</td>
<td>±80.66</td>
<td>±80.48</td>
<td>±79.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(225-500)</td>
<td>(315-500)</td>
<td>(400-600)</td>
<td>(225-600)</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>370</td>
<td>395</td>
<td>508*</td>
<td>424</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±80.61</td>
<td>±90.82</td>
<td>±90.87</td>
<td>±87.43</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(225-495)</td>
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+ = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level
within Parenthesis - Range
Table- 104  Change in width average of xylem fibre in the shoot axis of *Linum usitatissimum* L. var. Mukta at different height levels of plants of *M*₂ generation treated with different gamma-ray doses.

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<th>Doses in Krad</th>
<th>Mean Fibre Width (μm) in shoot axis</th>
<th>Base</th>
<th>Middle</th>
<th>Upper</th>
<th>Grand Mean</th>
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<td>17.9 ± 3.06</td>
<td>15.6 ± 2.46</td>
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<td>1.8832</td>
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* = Standard deviation
L.S.D. = Least significant difference
* = Significant at 5% level
within Parenthesis - Range