II. EVOLVING NEW VARIETIES THROUGH HYBRIDIZATION AND INDUCTION OF MUTATION AND POLYPLOIDY

INTRODUCTION

Hybridisation and induction of mutation play an important role in evolving new cultivars. The use of mutation breeding and induced polyploidy in ornamental bulbous plants is relatively a new idea. But better cultivars with respect to colour of flower and other morphological features as well as hardy plants are readily produced by means of interspecific and intergeneric hybridisation. North (1976) reported successful interspecific crosses of Lilium. Similarly, successful crosses between distantly related species of lilies resulting in production of normal seeds have been reported by Asano et al. (1977).

Mutation breeding makes use of the possibility of altering genes by exposing seeds or other plant parts to chemical or physical mutagens. Mutation can be induced by chemicals, such as ethyl methane sulphonate (EMS), diethyl sulphate (DES) or various types of ionizing radiation, such as X-rays, gamma-rays, neutrons, ultraviolet light etc.
Various chemical mutagens have been extensively used by Dryagina et al. (1972) to stimulate germination, growth, flowering and vegetative reproduction of ornamental bulbous plants. She treated corms with chemicals which included di-methyl sulphate (DMS), N-nitroso-N-methyl urethane (NMU) and nitroso di-methyl urea (NDMU).

Apart from a general paper by Konzak and Randolph (1956) and a publication about the non-genetic effects of gamma radiation (Halevy and Shoub, 1965), not much work has been published concerning mutation breeding in Iris. Hekstra and Broertjes (1968) irradiated dormant bulbs of the sterile Iris cv. Wedgewood with various doses of X-rays and obtained several flower colours and other mutations.

Grabowska (1975) noted that treatments with gamma irradiation at 500-2000 rad at late developmental stages of gladioli had a regular effect on advancing flowering. Seilleur (1975) found that the flowering was advanced when gladioli corms were exposed to lower doses of gamma irradiation. Takan et al. (1977) irradiated gladiolus cormel with gamma rays at 1000-3000 r and found that irradiation had no significant effect on plant vigour. The plants from bulbs of narcissus irradiated with gamma ray at 0.1 and 0.25 Kr. grew normally and in the third year after irradiation 15-20% more plants flowered in comparison to the control (Chemarin et al., 1977). Das et al. (1975) reported that the lower doses of gamma irradiation (3-4 KR) to dahlia tubers
increased the size of flowers. A colour mutant with light yellow flowers in gladioli was produced following gamma irradiation at 5 Krad (Mies, 1976). Gupta et al. (1974) isolated two mutants in tuberose cultivars using 2 K gamma rays. Eleven mutants with leaf colour variation were isolated in tuberose (Abraham and Desai, 1976). Broertjes and Ballego (1967) made a remarkable contribution in the induction of mutation in dahlia and a number of mutants had been released in Netherlands by their efforts.

Iris are extremely susceptible to adverse climatic condition as well as various diseases. Tolerance with respect to these factors is expected to be increased by producing polyploid plants. Moreover, polyploidy may increase the size of flowers also. Due to the work of Blakeslee and Avery (1937), it has been established that treatment with the colchicine, an alkaloid, is a simple and reliable means of doubling the chromosome number. Use of colchicine for the induction of polyploidy and as a consequence the alterations of the characters of the ornamental bulbous plants may be sufficient enough to make it a new variety. Havcova et al. (1976) reported that the induction of polyploidy by exposure to nitrous oxide produced the tetraploid plants in tulips. Colchicine induced polyploidy in relation to ornamental bulbous plants was reported by Bali and Tandon (1956). Behara et al. (1974) reported the histological analysis of colchicine induced deformities and cytochimeras in *Amaranthus candsatus* and *A. dubius*.
In order to evolve new varieties with respect to colour of flowers and other morphological features as well as hardy plants through interspecific and intergeneric crosses involving allied genera and induction of mutation by chemical and physical mutagens and polyploidy by colchicine, the present investigation was carried out.

**MATERIALS AND METHODS**

**Preparation of land**

The land was prepared well by thorough ploughing and harrowing incorporating leaf-mould and dry cow dung at the rate of 2-cartloads per acre. A top dressing with single super phosphate at the rate of 10 kilogram per acre was applied with a view to check "rhizome rot". The land was then divided into several plots according to the treatments. Five kilograms of well-rotted farm-yard manure per plot were also applied at the time of final preparation of soil.

**Selection and planting of rhizomes/plantlets**

**Rhizome**: Rhizomes of average size (length 5.0 cm and diameter 2.0 cm) and weight (15 g) were selected.

**Plantlets**: The average length of the young plantlets were 8.0 cm with 2 leaves.
Table 1 (a). Expression of heterosis in F$_1$ hybrids over mid and better parents (percentage).

<table>
<thead>
<tr>
<th>Hybrids</th>
<th>Height of plants (cm)</th>
<th>No. of leaves per plant</th>
<th>No. of plantlets per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I-yr.</td>
<td>II-yr.</td>
<td>I-yr.</td>
</tr>
<tr>
<td>Mid parent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IA X MI</td>
<td>-22.55</td>
<td>-45.85</td>
<td>-0.19</td>
</tr>
<tr>
<td>MI X IA</td>
<td>43.36</td>
<td>29.19</td>
<td>77.63</td>
</tr>
<tr>
<td>IS X IF</td>
<td>-52.96</td>
<td>37.71</td>
<td>-49.32</td>
</tr>
<tr>
<td>IF X IS</td>
<td>-53.44</td>
<td>-29.59</td>
<td>6.30</td>
</tr>
<tr>
<td>Better parent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IA X MI</td>
<td>-49.65</td>
<td>-63.00</td>
<td>-26.85</td>
</tr>
<tr>
<td>MI X IA</td>
<td>-6.81</td>
<td>-11.79</td>
<td>30.16</td>
</tr>
<tr>
<td>IS X IF</td>
<td>-55.98</td>
<td>34.61</td>
<td>-51.99</td>
</tr>
<tr>
<td>IF X IS</td>
<td>-56.43</td>
<td>-31.18</td>
<td>0.70</td>
</tr>
</tbody>
</table>
### Table 2: Flowering behaviour of parents and hybrids.

<table>
<thead>
<tr>
<th>Plants</th>
<th>Days to 1st flower bud appearance</th>
<th>Number of flowers per inflorescence</th>
<th>Length of flower (cm)</th>
<th>Breadth of flower (cm)</th>
<th>Longevity of flower (days)</th>
<th>Duration of flowering (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I-yr</td>
<td>II-yr</td>
<td>I-yr</td>
<td>II-yr</td>
<td>I-yr</td>
</tr>
<tr>
<td>IA</td>
<td>1658.50</td>
<td>1.00</td>
<td>1.00</td>
<td>17.50</td>
<td>17.50</td>
<td>1.00</td>
</tr>
<tr>
<td>MI</td>
<td>946.00</td>
<td>1.00</td>
<td>1.00</td>
<td>41.81</td>
<td>39.30</td>
<td>2.13</td>
</tr>
<tr>
<td>IA X MI</td>
<td>1687.50</td>
<td>1.05</td>
<td>1.12</td>
<td>10.75</td>
<td>10.77</td>
<td>1.50</td>
</tr>
<tr>
<td>MI X IA</td>
<td>961.50</td>
<td>1.05</td>
<td>1.12</td>
<td>77.39</td>
<td>49.13</td>
<td>1.73</td>
</tr>
<tr>
<td>IS</td>
<td>1619.00</td>
<td>1.00</td>
<td>1.00</td>
<td>10.68</td>
<td>10.68</td>
<td>1.50</td>
</tr>
<tr>
<td>IF</td>
<td>1316.50</td>
<td>1.00</td>
<td>1.02</td>
<td>17.60</td>
<td>12.00</td>
<td>1.00</td>
</tr>
<tr>
<td>IS X IF</td>
<td>1357.50</td>
<td>1.05</td>
<td>1.05</td>
<td>10.40</td>
<td>10.40</td>
<td>1.00</td>
</tr>
<tr>
<td>IF X IS</td>
<td>1177.50</td>
<td>1.07</td>
<td>1.05</td>
<td>17.83</td>
<td>17.83</td>
<td>1.33</td>
</tr>
</tbody>
</table>

LSD at 0.05 P: 16.18 NS 0.62 0.53 NS NS 2.18 1.11 1.11 0.53 1.42 NS 1.34 1.13

LSD at 0.01 P: 23.93 NS NS 0.92 0.78 NS NS 3.22 1.64 1.64 0.78 2.09 NS 1.97 1.67

NS = Not significant
### Table 2 (a) Expression of heterosis in F₁ hybrids over mid and better parents (percentage)

<table>
<thead>
<tr>
<th>Hybrids</th>
<th>Days to first flower appearance</th>
<th>Number of inflorescence per plant</th>
<th>Length of inflorescence (cm)</th>
<th>Number of flowers per inflorescence</th>
<th>Length of flower (cm)</th>
<th>Breadth of flower (cm)</th>
<th>Longevity of flowers (days)</th>
<th>Duration of flowering</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mid parent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IA X MI</td>
<td>29.58</td>
<td>5.00</td>
<td>12.00</td>
<td>-36.78</td>
<td>-33.91</td>
<td>-4.46</td>
<td>25.00</td>
<td>-26.17</td>
</tr>
<tr>
<td>MI X IA</td>
<td>-26.17</td>
<td>5.00</td>
<td>12.00</td>
<td>160.92</td>
<td>72.99</td>
<td>10.19</td>
<td>45.8</td>
<td>21.93</td>
</tr>
<tr>
<td>IS X IF</td>
<td>-7.51</td>
<td>5.00</td>
<td>3.96</td>
<td>-26.45</td>
<td>-8.29</td>
<td>-20.00</td>
<td>-20.00</td>
<td>23.31</td>
</tr>
<tr>
<td>IF X IS</td>
<td>-19.78</td>
<td>7.00</td>
<td>3.96</td>
<td>26.10</td>
<td>57.23</td>
<td>6.40</td>
<td>6.40</td>
<td>21.00</td>
</tr>
<tr>
<td><strong>Better parent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IA X MI</td>
<td>1.74</td>
<td>5.00</td>
<td>12.00</td>
<td>-55.15</td>
<td>-52.23</td>
<td>-29.57</td>
<td>7.14</td>
<td>3.33</td>
</tr>
<tr>
<td>MI X IA</td>
<td>-42.02</td>
<td>5.00</td>
<td>12.00</td>
<td>85.09</td>
<td>25.01</td>
<td>-18.77</td>
<td>25.00</td>
<td>19.41</td>
</tr>
<tr>
<td>IS X IF</td>
<td>-16.15</td>
<td>5.00</td>
<td>2.94</td>
<td>-40.90</td>
<td>-13.33</td>
<td>-33.33</td>
<td>-33.33</td>
<td>13.75</td>
</tr>
<tr>
<td>IF X IS</td>
<td>-27.26</td>
<td>7.00</td>
<td>2.94</td>
<td>1.30</td>
<td>48.58</td>
<td>-11.33</td>
<td>-11.33</td>
<td>11.62</td>
</tr>
</tbody>
</table>
cross did not show much improvement in flower quality.

The duration of flowering was considerably extended in hybrids resulting from cross between IA x MI and MI x IA. In the hybrids obtained from IF x IS cross also, flowering was continued for a longer period than the parents.

**Colour of flowers and other attributes**

A clear recombination was found in the colour of flower of two parents where complete dominance was absent. The colour of the falls clearly resembled the character of male parent and the standards were like that of a typical female parent which might be linked or exhibiting pleiotropic effect. The expressivity of $F_1$ pigmentation for intensity derived from two parents became true-to-the-type with the advancement of the flowering season due to incomplete penetrance. The colour of flower and other attribute for all the plant (parents and hybrids) are summarised below:

<table>
<thead>
<tr>
<th>Plants</th>
<th>Flower colour</th>
<th>Other attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>Bright yellow. Standards white lined on the base</td>
<td>Hardy plants</td>
</tr>
<tr>
<td>MI</td>
<td>Pure white. Standards are lined centrally on the rib with light yellow</td>
<td>Hardy and disease resistant plants; it flowers perpetually and sets fruits freely. Each fruit contains 6-8 viable seeds</td>
</tr>
</tbody>
</table>

Contd...
<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA x MI</td>
<td>Yellowish white. Falls yellowish lined with white in the centre; standards having deep brown spot at the base are yellowish in colour. Anther white. Carpet yellowish white.</td>
<td>The plants are very hardy and disease and frost resistant. It grows vigorously and flowers perpetually. Fruits set freely, each have 10-12 seeds.</td>
<td></td>
</tr>
<tr>
<td>MI x IA</td>
<td>Whitish yellow. Falls white lined with hairy deep yellow in the centre. Standards - Whitish yellow with deep brown spots at the base. Anther white. Carpet - yellowish white with light violet in the centre.</td>
<td>Same as above</td>
<td></td>
</tr>
<tr>
<td>IS</td>
<td>Deep lilac blue. Falls - bright lilac, veined with bright violet, whitish towards the claw.</td>
<td>This hardy plant has fibrous root system. Rhizomes are small, slender and appear in a cluster. It sets fruits freely, each containing 12-15 small seeds.</td>
<td></td>
</tr>
<tr>
<td>IF</td>
<td>Lavender colour, claw yellowish veined with purple. Falls - purple veined. Standards - white</td>
<td>Sensitive to rhizome rot. Abundant fruiting. One fruit contain 5-8 seeds</td>
<td></td>
</tr>
</tbody>
</table>

(Contd..)
Photographs showing flowers of *Moreae iridioides* (top left), *Iris aurea* (top right) and their hybrid (bottom centre).
Experiment II(a) : Induction of mutation by chemical mutagens

Growth and flowering behavior of a few morphological and flowering variants obtained following treatments with EMS (ethyl-methane-sulphonate) are described hereunder:

(a) Iris tectorum

In case of I. tectorum, the variants obtained following treatments with 0.50 per cent EMS at different pH showed maximum growth in respect of plant height, leaf and plantlet number (Table 3). Variants obtained from rhizomes treated with 0.25 per cent EMS also showed greater growth increase than the control. Plants developed from rhizomes treated with 1.00 per cent EMS at various pH did not show much growth differences from the control plants.

It is evident from data in Table 4 that treatment of rhizomes with 0.25 per cent EMS at pH 4.0 resulted in plants which did not flower during
the period reported here. Early flowering was recorded in plants obtained from rhizomes treated with 0.25 per cent EMS at pH 7.0 and 0.50 per cent EMS at pH 9.2. On the other hand, flowering was considerably delayed in plants developed as a result of treatment of rhizomes with 0.25 and 1.00 per cent EMS at pH 9.2. It was further noted that EMS at different concentrations had no significant effect on the yield of inflorescence per plant. But such inflorescences were larger in size and contained larger number of flowers than the control. EMS at 0.25 and 0.50 per cent showed consistent improvement in yield and quality of flowers; the flowers were larger in size and lasted longer than the control. Treatment with 1.00 per cent EMS also showed improvement in the quality of flowers but to a lesser extent as compared to 0.25 or 0.50 per cent EMS.

Data in Table 5 show the effect of EMS on the yield of rhizomes. 0.5 per cent EMS at pH 7.0 produced plants which yielded maximum number of daughter rhizomes. 0.5 per cent EMS at pH 4.0 and 9.2 also yielded larger number of rhizomes than other treatments including control. Such daughter rhizomes were larger in size than others. The yield of rhizomes was appreciably lower in plants resulting from treatments with 0.25 per cent EMS at pH 4.0 and 1.00 per cent EMS at pH 9.2.

Mutation frequency

Data in Table 6 show that regardless of pH, EMS at a concentration of
Table 3. Effect of ethyl-methane-sulphonate on growth of Iris tectorum.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Height of plant (cm)</th>
<th>Number of leaves per plant</th>
<th>Number of plantlets per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>18.66</td>
<td>56.68</td>
<td>59.11</td>
</tr>
<tr>
<td>Ethyl methane sulphonate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25% - pH = 4.0</td>
<td>13.55</td>
<td>45.38</td>
<td>56.61</td>
</tr>
<tr>
<td>0.25% - pH = 7.0</td>
<td>17.25</td>
<td>68.65</td>
<td>66.23</td>
</tr>
<tr>
<td>0.25% - pH = 9.2</td>
<td>18.19</td>
<td>58.03</td>
<td>68.06</td>
</tr>
<tr>
<td>0.50% - pH = 4.0</td>
<td>20.24</td>
<td>62.06</td>
<td>67.69</td>
</tr>
<tr>
<td>0.50% - pH = 7.0</td>
<td>20.95</td>
<td>61.15</td>
<td>68.57</td>
</tr>
<tr>
<td>0.50% - pH = 9.2</td>
<td>21.20</td>
<td>61.16</td>
<td>67.68</td>
</tr>
<tr>
<td>1% - pH = 4.0</td>
<td>17.41</td>
<td>55.53</td>
<td>60.14</td>
</tr>
<tr>
<td>1% - pH = 7.0</td>
<td>15.54</td>
<td>53.08</td>
<td>61.06</td>
</tr>
<tr>
<td>1% - pH = 9.2</td>
<td>17.33</td>
<td>55.68</td>
<td>57.28</td>
</tr>
<tr>
<td>LSD at 0.05 P</td>
<td>0.39</td>
<td>0.32</td>
<td>0.23</td>
</tr>
<tr>
<td>LSD at 0.01 P</td>
<td>0.56</td>
<td>0.46</td>
<td>0.33</td>
</tr>
</tbody>
</table>

N.S. = Not significant
<table>
<thead>
<tr>
<th>pH</th>
<th>Days to first flower bud appearance</th>
<th>Number of inflorescence per plant</th>
<th>Length of inflorescence (cm)</th>
<th>Number of flowers per inflorescence</th>
<th>Length of flower (cm)</th>
<th>Breadth of flower (cm)</th>
<th>Longevity of flower (days)</th>
<th>Duration of flowering (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>360.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>20.00</td>
<td>30.00</td>
<td>31.10</td>
<td>3.00</td>
</tr>
<tr>
<td>7.0</td>
<td>360.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>32.25</td>
<td>32.25</td>
<td>32.25</td>
<td>7.75</td>
</tr>
<tr>
<td>9.0</td>
<td>360.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>31.26</td>
<td>28.48</td>
<td>3.50</td>
<td>2.00</td>
</tr>
<tr>
<td>8.0</td>
<td>360.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>17.50</td>
<td>28.28</td>
<td>33.05</td>
<td>1.00</td>
</tr>
<tr>
<td>8.2</td>
<td>360.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>31.10</td>
<td>30.50</td>
<td>32.67</td>
<td>7.75</td>
</tr>
<tr>
<td>4.0</td>
<td>360.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>22.00</td>
<td>26.10</td>
<td>27.50</td>
<td>1.00</td>
</tr>
<tr>
<td>7.0</td>
<td>360.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>19.20</td>
<td>33.20</td>
<td>26.60</td>
<td>1.00</td>
</tr>
<tr>
<td>9.2</td>
<td>360.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>19.50</td>
<td>19.50</td>
<td>19.50</td>
<td>3.00</td>
</tr>
<tr>
<td>0.5</td>
<td>43.40</td>
<td>0.19</td>
<td>NS</td>
<td>NS</td>
<td>1.92</td>
<td>2.04</td>
<td>0.95</td>
<td>0.67</td>
</tr>
<tr>
<td>0.1</td>
<td>63.21</td>
<td>0.28</td>
<td>NS</td>
<td>NS</td>
<td>2.80</td>
<td>2.98</td>
<td>1.38</td>
<td>0.95</td>
</tr>
</tbody>
</table>

NS = Not significant
Table 5. Effect of ethyl-methane-sulphonate on rhizome formation of *Iris tectorum*.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of rhizomes produced per plant</th>
<th>Weight of rhizomes (gm)</th>
<th>Length of rhizome (cm)</th>
<th>Diameter of rhizome (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>14.20</td>
<td>116.87</td>
<td>7.55</td>
<td>2.82</td>
</tr>
<tr>
<td>Ethyl-methane-sulphonate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25% - pH = 4.0</td>
<td>8.00</td>
<td>101.98</td>
<td>10.08</td>
<td>2.94</td>
</tr>
<tr>
<td>0.25% - pH = 7.0</td>
<td>16.60</td>
<td>115.61</td>
<td>11.62</td>
<td>4.09</td>
</tr>
<tr>
<td>0.25% - pH = 9.2</td>
<td>19.00</td>
<td>114.93</td>
<td>10.40</td>
<td>2.81</td>
</tr>
<tr>
<td>0.50% - pH = 4.0</td>
<td>23.20</td>
<td>119.58</td>
<td>14.67</td>
<td>4.36</td>
</tr>
<tr>
<td>0.50% - pH = 7.0</td>
<td>28.80</td>
<td>116.99</td>
<td>13.88</td>
<td>4.30</td>
</tr>
<tr>
<td>0.50% - pH = 9.2</td>
<td>23.60</td>
<td>118.25</td>
<td>13.64</td>
<td>4.36</td>
</tr>
<tr>
<td>1% - pH = 4.0</td>
<td>14.80</td>
<td>116.81</td>
<td>8.38</td>
<td>2.92</td>
</tr>
<tr>
<td>1% - pH = 7.0</td>
<td>12.00</td>
<td>115.98</td>
<td>7.81</td>
<td>2.89</td>
</tr>
<tr>
<td>1% - pH = 9.2</td>
<td>8.80</td>
<td>102.55</td>
<td>7.64</td>
<td>2.81</td>
</tr>
</tbody>
</table>
Table 6. Mutation frequency in Iris tectorum at different doses of ethylene-sulphonate

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of treated rhizomes</th>
<th>Number of mutated plants</th>
<th>Mutation frequency (per cent)</th>
<th>Number colour</th>
<th>Induced Change</th>
<th>Other attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Normal flowers</td>
</tr>
<tr>
<td>Ethyl-methane sulphonate</td>
<td></td>
<td></td>
<td></td>
<td>Bright lilac/loral tube yellowish</td>
<td>-</td>
<td>Did not flower</td>
</tr>
<tr>
<td>0.25% - pH = 4.0</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>Bright lilac/loral tube yellowish</td>
<td>-</td>
<td>Mutant flowers with four bearded standards, three styles and three anthers.</td>
</tr>
<tr>
<td>0.25% - pH = 7.0</td>
<td>5</td>
<td>2</td>
<td>40</td>
<td>Bright lilac/loral tube yellowish</td>
<td>-</td>
<td>Mutant flowers with four bearded standards, three styles and three anthers.</td>
</tr>
<tr>
<td>0.25% - pH = 4.0</td>
<td>5</td>
<td>3</td>
<td>60</td>
<td>Deep lilac standard - deep black on the basaloral tube whitish green</td>
<td>-</td>
<td>Mutant flowers - one having one extra falls on the lower side. One with four beared standards, four styles and four anthers.</td>
</tr>
<tr>
<td>0.50% - pH = 4.0</td>
<td>5</td>
<td>5</td>
<td>100</td>
<td>Deep lilac standard - deep black on the basaloral tube whitish green</td>
<td>-</td>
<td>Mutant flowers - one bearing one extra falls, one created standard and two normal standards, another one mutant flower with four beared standards with three styles. One plant having three very big flower spikes with four branches.</td>
</tr>
<tr>
<td>0.50% - pH = 7.0</td>
<td>5</td>
<td>3</td>
<td>100</td>
<td>Deep lilac standard - deep black on the basaloral tube whitish green</td>
<td>-</td>
<td>Mutant flowers - one bearing three falls, one created standard, two normal standards and two styles (stigma). One bearing four beared standards with three styles. Another one bearing a very big standard while other three normal with three styles. One plant bearing a very big (about 40 cm) flower spike with four beared mutant flowers with three styles, one in centre of 5 cm long. Early flowering - one mutant flower bearing four beared standards only.</td>
</tr>
<tr>
<td>0.50% - pH = 9.2</td>
<td>5</td>
<td>5</td>
<td>100</td>
<td>Deep lilac/loral tube - whiteish shade towards the upper end.</td>
<td>-</td>
<td>Mutant flowers - one bearing three falls, one created standard, two normal standards and two styles (stigma). One bearing four beared standards with three styles. Another one bearing a very big standard while other three normal with three styles. One plant bearing a very big (about 40 cm) flower spike with four beared mutant flowers with three styles, one in centre of 5 cm long. Early flowering - one mutant flower bearing four beared standards only.</td>
</tr>
<tr>
<td>1% - pH = 4.0</td>
<td>5</td>
<td>1</td>
<td>20</td>
<td>Bright lilac/loral tube yellowish</td>
<td>-</td>
<td>Mutant flowers - one bearing four beared standards with three styles.</td>
</tr>
<tr>
<td>1% - pH = 7.0</td>
<td>5</td>
<td>1</td>
<td>20</td>
<td>Bright lilac/loral tube - yellowish green.</td>
<td>-</td>
<td>Mutant flowers - one bearing four beared standards with three styles.</td>
</tr>
<tr>
<td>1% - pH = 9.2</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>Bright lilac/loral tube - Yellowish green.</td>
<td>-</td>
<td>Mutant flowers - one bearing four beared standards with three styles.</td>
</tr>
</tbody>
</table>

Rhizomes of two plants rotted due to "rhizome-rot". Normal flowers - one bearing four beared standards with three styles.

Normal flowers.
Photographs showing flowers in mutants of *I. tectorum*, obtained following treatment with 0.50 per cent EMS at pH 4.0.
Photograph showing flowers in mutants of *I. tectorum*, obtained following treatment with 0.50 per cent at pH 7.0.
Photographs showing flowers in mutants of *I. tectorum*, obtained following treatment with 0.50 per cent EMS at pH 9.2.
Photographs showing flowers in mutants of *L. lectorum*, obtained following treatment with 0.50 per cent EMS at pH 9.2.
0.5 per cent induced mutations in all treated plants. Treatment with 0.25 per cent EMS at pH 7.0 and 9.2 also resulted in 40 and 60 per cent mutation, respectively. In contrast, 1.00 per cent EMS at pH 9.2 did not reproduce any mutated plant, and at pH 4.0 and 7.0 only 20 per cent of the treated plants showed changes in the form of flowers.

(b) Iris graminea

In case of I. graminea, 0.25 and 0.50 per cent EMS at pH 7.0 and 9.2 resulted in plants which showed superior vegetative growth in respect of plant height and number of leaves and plantlets produced per plant (Table 7). 0.50 and 1.00 per cent EMS at pH 4.0 was proved lethal to the plantlets of I. graminea. As regards flowering of variants, it has been found that only the plants obtained following treatments with 0.25 per cent EMS at pH 7.0 and 0.50 per cent EMS at pH 9.2 showed consistent increase in the yield of flowers of better quality (Table 8). Other treatments were of no appreciable effect on yield of flowers.

Table 9 show the yield of rhizomes as affected by treatment of seedling with EMS. 0.5 per cent EMS either at pH 7.0 or 9.2 resulted in higher yield of rhizomes than other treatments including control.

Mutation frequency

It is evident from Table 10 that mutation frequency was highest (100
### Table 8: Effect of ethyl-methane-sulphonate on flowering of Iris graminea

<table>
<thead>
<tr>
<th></th>
<th>First flower bud appearance (days)</th>
<th>Number of inflorescence per plant</th>
<th>Length of inflorescence (cm)</th>
<th>Number of flowers per inflorescence</th>
<th>Length of flower (cm)</th>
<th>Breadth of flower (cm)</th>
<th>Longevity of flower (days)</th>
<th>Duration of flowering (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>235.00</td>
<td>2.00</td>
<td>2.25</td>
<td>9.88</td>
<td>1.50</td>
<td>8.00</td>
<td>10.00</td>
<td>2.50</td>
</tr>
<tr>
<td><strong>ethyl-methane-</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>sulphonate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25%</td>
<td>600.00</td>
<td>1.33</td>
<td>1.66</td>
<td>1.33</td>
<td>8.50</td>
<td>11.06</td>
<td>8.90</td>
<td>5.50</td>
</tr>
<tr>
<td>25%</td>
<td>302.50</td>
<td>3.00</td>
<td>2.60</td>
<td>2.00</td>
<td>9.00</td>
<td>11.00</td>
<td>11.20</td>
<td>5.33</td>
</tr>
<tr>
<td>25%</td>
<td>235.00</td>
<td>1.50</td>
<td>1.80</td>
<td>2.40</td>
<td>9.00</td>
<td>9.08</td>
<td>10.00</td>
<td>7.50</td>
</tr>
<tr>
<td>50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td>310.00</td>
<td>1.33</td>
<td>3.00</td>
<td>2.20</td>
<td>9.60</td>
<td>12.15</td>
<td>9.84</td>
<td>2.66</td>
</tr>
<tr>
<td>50%</td>
<td>235.00</td>
<td>1.60</td>
<td>2.60</td>
<td>2.60</td>
<td>9.60</td>
<td>11.08</td>
<td>9.76</td>
<td>3.00</td>
</tr>
<tr>
<td>40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td>308.50</td>
<td>1.00</td>
<td>1.50</td>
<td>2.00</td>
<td>8.20</td>
<td>9.70</td>
<td>9.50</td>
<td>2.00</td>
</tr>
<tr>
<td>40%</td>
<td>231.00</td>
<td>1.00</td>
<td>1.66</td>
<td>2.50</td>
<td>10.20</td>
<td>9.96</td>
<td>9.75</td>
<td>1.00</td>
</tr>
<tr>
<td>30%</td>
<td>12.26</td>
<td>0.62</td>
<td>NS</td>
<td>NS</td>
<td>1.08</td>
<td>1.27</td>
<td>1.36</td>
<td>1.57</td>
</tr>
<tr>
<td>30%</td>
<td>18.13</td>
<td>0.92</td>
<td>NS</td>
<td>NS</td>
<td>1.60</td>
<td>1.88</td>
<td>2.00</td>
<td>2.32</td>
</tr>
<tr>
<td>20%</td>
<td>12.26</td>
<td>0.62</td>
<td>NS</td>
<td>NS</td>
<td>1.08</td>
<td>1.27</td>
<td>1.36</td>
<td>1.57</td>
</tr>
<tr>
<td>20%</td>
<td>18.13</td>
<td>0.92</td>
<td>NS</td>
<td>NS</td>
<td>1.60</td>
<td>1.88</td>
<td>2.00</td>
<td>2.32</td>
</tr>
<tr>
<td>10%</td>
<td>12.26</td>
<td>0.62</td>
<td>NS</td>
<td>NS</td>
<td>1.08</td>
<td>1.27</td>
<td>1.36</td>
<td>1.57</td>
</tr>
<tr>
<td>10%</td>
<td>18.13</td>
<td>0.92</td>
<td>NS</td>
<td>NS</td>
<td>1.60</td>
<td>1.88</td>
<td>2.00</td>
<td>2.32</td>
</tr>
<tr>
<td>NS</td>
<td>12.26</td>
<td>0.62</td>
<td>NS</td>
<td>NS</td>
<td>1.08</td>
<td>1.27</td>
<td>1.36</td>
<td>1.57</td>
</tr>
<tr>
<td>NS</td>
<td>18.13</td>
<td>0.92</td>
<td>NS</td>
<td>NS</td>
<td>1.60</td>
<td>1.88</td>
<td>2.00</td>
<td>2.32</td>
</tr>
<tr>
<td>NS</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatments</td>
<td>Number of roots produced per plant</td>
<td>Weight of roots (gm)</td>
<td>Length of roots (cm)</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>
</tr>
<tr>
<td>Control</td>
<td>16.03</td>
<td>237.03</td>
<td>8.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethyl-methane-sulphonate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25% - pH = 4.0</td>
<td>14.60</td>
<td>240.91</td>
<td>10.92</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25% - pH = 7.0</td>
<td>15.67</td>
<td>195.37</td>
<td>9.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>0.25% - pH = 9.2</td>
<td>17.36</td>
<td>334.45</td>
<td>14.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50% - pH = 4.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50% - pH = 7.0</td>
<td>21.74</td>
<td>489.24</td>
<td>20.00</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>0.50% - pH = 9.2</td>
<td>22.75</td>
<td>481.38</td>
<td>19.86</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% - pH = 4.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% - pH = 7.0</td>
<td>16.75</td>
<td>305.75</td>
<td>16.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% - pH = 9.2</td>
<td>16.99</td>
<td>260.08</td>
<td>9.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Photographs showing flowers in mutants of *I. grominea*, obtained following treatment with 0.5% per cent EMS at pH 7.0.
Photographs showing flowers in mutants of *L. graminea*, obtained following treatment with 0.50 per cent EMS at pH 9.2.
per cent) under 0.50 per cent EMS at pH 9.2 closely followed by the same concentration of EMS at pH 7.0 (80 per cent). The common floral changes that occurred under these treatments are summarized in Table 10. Lower concentration of EMS (0.25 per cent) at pH 4.0 and 7.0 also produced 40 and 60 per cent mutation. It is of interest to note that higher concentration of EMS (1.00 per cent) did not induce any mutation.

From the results presented above it is clearly evident that 0.50 per cent EMS at pH 7.0 and 9.2 is a potent chemical for inducing mutation in irises. Changes in the form and colour of flowers offer scope for releasing new varieties of irises.

Experiment 11(b) : Induction of mutation by physical mutagen

Effect of growth, flowering and rhizome formation

For induction of mutation by physical mutagen, rhizomes of Iris tectorum were exposed to different doses of gamma radiation. It was found that with the increase in radiation doses beyond 200 r, there was reduction in vegetative growth resulting in stunted plants as evident from reduced plant height and less number of leaves and plantlets produced per plant (Table 11). Growth reduction as a result to gamma irradiation has been reported by several workers
Table 10: Mutation frequency in *Iris germanica* at different doses of ethyl-methane-sulphonate.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of treated plantlets</th>
<th>Number of mutated plants</th>
<th>Mutation frequency (per cent)</th>
<th>Flower colour</th>
<th>Induced Change Other attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>White Blk spot on the standards.</td>
<td>Normal flowers.</td>
</tr>
<tr>
<td>Ethyl-methane-sulphonate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25% - pH = 4.0</td>
<td>5</td>
<td>2</td>
<td>40</td>
<td>White with deep black spot on the standards</td>
<td>Mutant flowers - One bearing four falls and four standards.</td>
</tr>
<tr>
<td>0.25% - pH = 7.0</td>
<td>5</td>
<td>3</td>
<td>60</td>
<td>White with deep black spot on the standards</td>
<td>Mutant flowers bearing four numbers of falls and standards.</td>
</tr>
<tr>
<td>0.25% - pH = 9.2</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>White, Blk spot on the standards.</td>
<td>Normal flowers.</td>
</tr>
<tr>
<td>0.50% - pH = 4.0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>White with deep black spot on the standards.</td>
<td>Normal flowers.</td>
</tr>
<tr>
<td>0.50% - pH = 7.0</td>
<td>5</td>
<td>4</td>
<td>80</td>
<td>Pinkish white, Yellowish spot on the standards.</td>
<td>Plant - one bearing maximum number of inflorescence (10) with very big flowers. One mutant flower bearing four numbers of falls and standards. One standard round-shaped.</td>
</tr>
<tr>
<td>0.5% - pH = 9.2</td>
<td>5</td>
<td>5</td>
<td>100</td>
<td>Pinkish white, Standards - Yellow spotted and milky White colour</td>
<td>Plant - one bearing eight inflorescence with big flowers, flowers having four numbers of falls and standards. Falls - somewhere one very big while other three small, somewhere attached with the other. Standards - twisted and serrated. Flower spikes branching habit.</td>
</tr>
<tr>
<td>1% - pH = 4.0</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>White with black spot on the standards.</td>
<td>Normal flowers.</td>
</tr>
<tr>
<td>1% - pH = 7.0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>White with black spot on the standards.</td>
<td>Normal flowers.</td>
</tr>
<tr>
<td>1% - pH = 9.2</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>White, Blk spot on the standards.</td>
<td>Normal flowers.</td>
</tr>
<tr>
<td>Treatments</td>
<td>Number of plantlets per plant</td>
<td>Number of leaves per plant</td>
<td>Height of plant (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------</td>
<td>---------------------------</td>
<td>---------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>15.07</td>
<td>1.40</td>
<td>6.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 R</td>
<td>17.69</td>
<td>1.70</td>
<td>8.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200 R</td>
<td>17.00</td>
<td>1.50</td>
<td>8.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 R</td>
<td>11.00</td>
<td>1.00</td>
<td>6.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 R</td>
<td>8.13</td>
<td>0.60</td>
<td>5.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 R</td>
<td>6.65</td>
<td>0.30</td>
<td>4.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LSD at 0.05 p</th>
<th>1.38</th>
<th>0.57</th>
<th>0.50</th>
<th>0.68</th>
<th>0.60</th>
<th>0.25</th>
<th>0.40</th>
<th>0.90</th>
<th>0.11</th>
<th>0.90</th>
<th>1.89</th>
</tr>
</thead>
</table>

| LSD at 0.01 p | 2.17 | 0.40 | 0.90 | 0.25 | 2.09 | 1.07 | 0.87 | 0.90 | 0.25 | 0.90 | 1.89 |

Table 11: Effect of gamma-ray on growth of Iris tectorum.
(Abraham and Desai, 1976; Das et al., 1977). Gunckel (1957) attributed the growth reduction to the inability of irradiated cells to utilize materials for its growth and development.

Data in Table 12 show that exposure to radiation generally resulted in earlier emergence of the first flower bud and there was no significant difference between the different doses of irradiation. It was further noted that gamma-radiation has no significant effect on the yield of flowers except exposure to 1000 r when the plants failed to flower during the course of this experiment. Exposure to 400 r also seemed to be inhibitory to flowering; flowers, under this treatment were smaller in size and lasted for a shorter period than the control. In contrast, plants resulting from rhizomes exposed to 200 r yielded significantly more flowers of better quality than the control plants. Other doses of irradiation showed no significant effect on flowering.

Besides the above mentioned effect on growth and flowering, various morphological peculiarities such as narrow leafy leaves, fused and bifurcated inflorescence, sectorial albino leaves etc. were also noticed in irradiated plants. These growth modifications were more or less similar to those reported in other horticultural crops (Gunke, 1957; Abraham and Desai, 1976; Das et al., 1977, 1980).

Data presented in Table 13 show that exposure to 200 r or 300 r resulted in production of larger number of daughter rhizomes with increase weight and
<table>
<thead>
<tr>
<th>Treatments</th>
<th>Days to first flower bud appearance</th>
<th>Number of inflorescences per plant</th>
<th>Length of inflorescence (cm)</th>
<th>Number of flowers per inflorescence</th>
<th>Length of flowers (cm)</th>
<th>Breadth of flowers (cm)</th>
<th>Longevity of flowers (days)</th>
<th>Duration of flowering (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-yr</td>
<td>II-yr</td>
<td>III-yr</td>
<td>I-yr</td>
<td>II-yr</td>
<td>III-yr</td>
<td>I-yr</td>
<td>II-yr</td>
<td>III-yr</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td>781.00</td>
<td>1.50</td>
<td>1.13</td>
<td>1.40</td>
<td>12.00</td>
<td>19.08</td>
</tr>
<tr>
<td>Gamma</td>
<td></td>
<td></td>
<td>750.00</td>
<td>1.00</td>
<td>1.40</td>
<td>1.00</td>
<td>11.00</td>
<td>17.20</td>
</tr>
<tr>
<td>At 0.05P</td>
<td></td>
<td></td>
<td>21.88</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>2.05</td>
<td>0.28</td>
</tr>
<tr>
<td>At 0.01P</td>
<td></td>
<td></td>
<td>341</td>
<td>0.65</td>
<td>1.22</td>
<td>NS</td>
<td>1.30</td>
<td>NS</td>
</tr>
<tr>
<td>Treatments</td>
<td>Number of rhizomes produced per plant</td>
<td>Weight of rhizomes (gm)</td>
<td>Length of rhizome (cm)</td>
<td>Diameter of rhizome (cm)</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>
</tr>
<tr>
<td>Control</td>
<td>9.00</td>
<td>87.20</td>
<td>8.33</td>
<td>3.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma-ray</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 r</td>
<td>7.00</td>
<td>65.15</td>
<td>7.85</td>
<td>2.87</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200 r</td>
<td>12.11</td>
<td>133.11</td>
<td>11.37</td>
<td>4.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 r</td>
<td>10.43</td>
<td>102.50</td>
<td>9.61</td>
<td>3.46</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 r</td>
<td>4.60</td>
<td>43.70</td>
<td>7.40</td>
<td>2.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 r</td>
<td>4.00</td>
<td>36.25</td>
<td>8.50</td>
<td>3.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Photographs showing flowers in mutants of *I. tectorum* obtained following treatment of rhizomes with 200 r (top) and 400 r (bottom) \( \gamma \)-radiation.
Photographs showing flowers in mutants of *L. tectorum*, obtained following treatment of rhizomes with 300 r 
γ - radiation.
size over other treatments including control; 200 r proved to be better than 300 r. Exposure to higher doses of radiation resulted in appreciable reduction in yield of daughter rhizomes.

Data in Table 14 show the mutation frequency as a result of gamma-irradiation. It is evident that mutation frequency was maximum under 200 r (70 per cent), followed by 300 r (50 per cent). The mutagenic effect of gamma radiation on flower colour and floral peculiarities are summarized in Table 14. These results are in general agreement with the findings of previous workers (Sheehan and Sagawa, 1959; Dryagina, 1962; Hekstra and Broertjes, 1968; Gupta et al., 1974). From practical point of view, these variations in the flowers of Iris tectorium are important for developing new varieties of attractive colour.

Experiment III: Induction of polyploidy

Attempts were made to induce polyploidy in two species of Iris viz. Iris germanica and I. tectorium by treatment of plantlets and rhizomes, respectively, with colchicine. The important findings are described hereunder.

(a) Iris germanica

It is clear from Table 15 that colchicine treatments stimulated the vegetative growth of I. germanica plants; 0.50 per cent colchicine being
Table 14. Mutation frequency in *Iris sertorium* at different doses of gamma-ray.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of treated rhizomes</th>
<th>Number of mutated rhizomes</th>
<th>Mutation frequency (per cent)</th>
<th>Induced Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>Normal flowers</td>
</tr>
<tr>
<td>Gamma-ray</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 r</td>
<td>10</td>
<td>3</td>
<td>30</td>
<td>Dwarf plant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>Deep lilac</em> flowers, Falls-</td>
<td>Big flowers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>whitish on the border.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>Standards</em> - deep lilac.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>Floral tube</em> - yellowish green</td>
<td></td>
</tr>
<tr>
<td>200 r</td>
<td>10</td>
<td>7</td>
<td>70</td>
<td>Big flowers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>Flower spikes</em> - branching</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>habit, 4 to 5 branches per</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>spike. One mutant flower</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>bearing one extra falls.</td>
<td></td>
</tr>
<tr>
<td>300 r</td>
<td>10</td>
<td>5</td>
<td>50</td>
<td>Big flowers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>Flower spikes</em> - long and</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>branching habit having 3 to</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 branches per spike</td>
<td></td>
</tr>
<tr>
<td>400 r</td>
<td>10</td>
<td>2</td>
<td>20</td>
<td>Flower spikes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1000 r</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>Did not flower</td>
</tr>
</tbody>
</table>
more effective than 0.25 per cent. As regards the effect of colchicine on flowering it has been found that colchicine treatments had no significant effect on the time of appearance of the first flower bud, nor it affected the number of inflorescence developed per plant (Table 15). The inflorescence, however, tended to increase in length bearing more flowers than the untreated control. Moreover, the flowers in colchicine treated plants were significantly larger in size and lasted longer than the control. The duration of flowering was also significantly extended; 0.50 per cent colchicine treatment was proved to be better than 0.25 per cent colchicine treatment. As evident from Table 17, the yield of daughter rhizomes also increased following treatments with 0.25 and 0.5 per cent colchicine, which resulted in 11.36 and 67.45 per cent increase in weight of daughter rhizomes over control, respectively.

(b) Iris tectorum

In another experiment, rhizomes of I. tectorum were soaked in different concentrations of colchicine for various periods. It is evident from data in Table 18 that soaking of rhizomes in 0.50 per cent colchicine for 48 hrs resulted in maximum growth increase of plants, followed by soaking in 0.50 per cent colchicine for 24 hrs. Soaking of rhizomes in 1.00 per cent colchicine proved to be injurious, the effect being more pronounced as the duration of soaking was increased from 24 hrs to 72 hrs. Treatment of rhizomes with 1.00 per cent colchicine for 48 or 72 hrs was found to be lethal. Soaking
Table 15. Effect of colchicine on growth of *Iris germanica*

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Height of plant</th>
<th>Number of leaves per plant</th>
<th>Number of plantlets per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I-yr.</td>
<td>II-yr.</td>
<td>I-yr.</td>
</tr>
<tr>
<td>Control</td>
<td>30.93</td>
<td>46.74</td>
<td>9.98</td>
</tr>
<tr>
<td>Colchicine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25%</td>
<td>34.77</td>
<td>52.77</td>
<td>11.71</td>
</tr>
<tr>
<td>0.50%</td>
<td>37.00</td>
<td>60.98</td>
<td>11.80</td>
</tr>
<tr>
<td>LSD at 0.05P</td>
<td>3.41</td>
<td>0.96</td>
<td>0.27</td>
</tr>
<tr>
<td>LSD at 0.01P</td>
<td>N.S.</td>
<td>2.22</td>
<td>0.63</td>
</tr>
<tr>
<td>Treatments</td>
<td>Days to flower bud emergence</td>
<td>Number of inflorescences per plant</td>
<td>Length of inflorescence (cm)</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------------</td>
<td>-----------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Control</td>
<td>520.00</td>
<td>1.67</td>
<td>1.50</td>
</tr>
<tr>
<td>Colchicine</td>
<td>0.25%</td>
<td>544.00</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>0.50%</td>
<td>515.00</td>
<td>2.00</td>
</tr>
<tr>
<td>LSD at 0.05 P</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>LSD at 0.01 P</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Treatments</td>
<td>Number of rhizomes produced per plant</td>
<td>Weight of rhizomes (gm)</td>
<td>Length of rhizome (cm)</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------</td>
<td>-------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Control</td>
<td>11.60</td>
<td>151.80</td>
<td>11.70</td>
</tr>
<tr>
<td>Colchicine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25%</td>
<td>12.00</td>
<td>173.60</td>
<td>12.00</td>
</tr>
<tr>
<td>0.50%</td>
<td>14.20</td>
<td>254.20</td>
<td>14.44</td>
</tr>
</tbody>
</table>
Table 18. Effect of colchicine on growth of Iris tectorum.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Height of plant (cm)</th>
<th>Number of leaves per plant</th>
<th>Number of plantlets per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I-yr.</td>
<td>II-yr.</td>
<td>I-yr.</td>
</tr>
<tr>
<td>Control</td>
<td>5.99</td>
<td>26.13</td>
<td>4.12</td>
</tr>
<tr>
<td>24 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colchicine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25%</td>
<td>5.77</td>
<td>28.10</td>
<td>3.52</td>
</tr>
<tr>
<td>0.50%</td>
<td>4.87</td>
<td>30.02</td>
<td>3.25</td>
</tr>
<tr>
<td>0.75%</td>
<td>5.80</td>
<td>27.48</td>
<td>3.50</td>
</tr>
<tr>
<td>1.00%</td>
<td>3.79</td>
<td>25.02</td>
<td>1.96</td>
</tr>
<tr>
<td>48 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colchicine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25%</td>
<td>7.31</td>
<td>26.26</td>
<td>3.48</td>
</tr>
<tr>
<td>0.50%</td>
<td>10.42</td>
<td>44.94</td>
<td>7.32</td>
</tr>
<tr>
<td>0.75%</td>
<td>7.68</td>
<td>30.32</td>
<td>5.44</td>
</tr>
<tr>
<td>1.00%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>72 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colchicine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25%</td>
<td>5.36</td>
<td>20.49</td>
<td>3.52</td>
</tr>
<tr>
<td>0.50%</td>
<td>6.88</td>
<td>30.02</td>
<td>4.68</td>
</tr>
<tr>
<td>0.75%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1.00%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LSD at 0.05 P</td>
<td>0.39</td>
<td>0.60</td>
<td>0.64</td>
</tr>
<tr>
<td>LSD at 0.01 P</td>
<td>0.56</td>
<td>0.96</td>
<td>0.92</td>
</tr>
</tbody>
</table>
of rhizomes in 0.75 per cent colchicine for 72 hrs also inhibited sprouting of rhizomes.

Data in Table 19 show that colchicine treatment for a period of 24 or 72 hrs caused appreciable delay in the appearance of the first flower bud and 1 per cent colchicine was found most effective. In contrast, flowering was advanced by 52 and 46 days when the rhizomes were soaked in 0.50 and 0.75 per cent colchicine, respectively for a period of 48 hrs. Treatments with 0.50 per cent colchicine, respectively for a period of 48 hrs. Treatments with 0.50 per cent colchicine for 48 hrs, resulted in the production of larger number of inflorescence per plant. The inflorescence under this treatment was also larger in size bearing more flowers of bigger size than the control.

Maximum increase in the yield (number and weight) of daughter rhizomes was also recorded under 0.5 per cent colchicine treatment, and 48 hours soaking was proved to be optimum duration of treatment (Table 20).

Cytological study

In both experiments, mitotic as well as meiotic studies were done in newly developed plants. It was observed that the number of chromosomes in colchicine treated plants was same as in control plants. The pairing of chromosomes and cell division was quite normal in colchicine-treated plants.
Table 19: Effect of colchicine on flowering of *Iris tectorum*.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Days to first flower</th>
<th>Number of inflorescences (per plant)</th>
<th>Length of inflorescence (cm)</th>
<th>Number of flowers per inflorescence</th>
<th>Length of flower (cm)</th>
<th>Breadth of flower (cm)</th>
<th>Longevity of flower (days)</th>
<th>Duration of flowering (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I-yr</td>
<td>II-yr</td>
<td>I-yr</td>
<td>II-yr</td>
<td>I-yr</td>
<td>II-yr</td>
<td>I-yr</td>
<td>II-yr</td>
</tr>
<tr>
<td>Control</td>
<td>358.50</td>
<td>1.00</td>
<td>1.00</td>
<td>5.90</td>
<td>7.54</td>
<td>1.00</td>
<td>1.00</td>
<td>4.08</td>
</tr>
<tr>
<td>24 hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colchicine</td>
<td>0·25%</td>
<td>665.00</td>
<td>1.00</td>
<td>1.00</td>
<td>5.61</td>
<td>6.74</td>
<td>1.33</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>0·50%</td>
<td>525.00</td>
<td>1.20</td>
<td>1.00</td>
<td>6.52</td>
<td>6.44</td>
<td>1.00</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>0·75%</td>
<td>650.00</td>
<td>1.00</td>
<td>1.00</td>
<td>6.10</td>
<td>8.46</td>
<td>1.33</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>1·00%</td>
<td>1027.00</td>
<td>1.00</td>
<td>1.00</td>
<td>8.50</td>
<td>8.50</td>
<td>1.00</td>
<td>00</td>
</tr>
<tr>
<td>48 hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colchicine</td>
<td>0·25%</td>
<td>650.00</td>
<td>1.00</td>
<td>1.00</td>
<td>6.50</td>
<td>7.88</td>
<td>2.00</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>0·50%</td>
<td>306.00</td>
<td>1.52</td>
<td>1.67</td>
<td>7.54</td>
<td>8.15</td>
<td>3.16</td>
<td>00</td>
</tr>
<tr>
<td></td>
<td>0·75%</td>
<td>312.00</td>
<td>1.18</td>
<td>1.18</td>
<td>6.50</td>
<td>7.60</td>
<td>2.09</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>1·00%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>72 hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colchicine</td>
<td>0·25%</td>
<td>645.00</td>
<td>1.00</td>
<td>1.00</td>
<td>6.00</td>
<td>8.10</td>
<td>1.00</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>0·50%</td>
<td>526.50</td>
<td>1.60</td>
<td>1.00</td>
<td>7.32</td>
<td>7.28</td>
<td>2.00</td>
<td>00</td>
</tr>
<tr>
<td></td>
<td>0·75%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1·00%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LSD at 0·05 P</td>
<td>20·10</td>
<td>2·23</td>
<td>0·23</td>
<td>1·04</td>
<td>0·60</td>
<td>1·17</td>
<td>90</td>
<td>0·96</td>
</tr>
<tr>
<td>LSD at 0·01 P</td>
<td>28·91</td>
<td>0·33</td>
<td>NS</td>
<td>1·49</td>
<td>0·86</td>
<td>NS</td>
<td>30</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS = N significant
<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of rhizomes produced per plant</th>
<th>Weight of rhizomes (gm)</th>
<th>Length of rhizome (cm)</th>
<th>Diameter of rhizome (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6.00</td>
<td>55.40</td>
<td>6.50</td>
<td>2.96</td>
</tr>
<tr>
<td><strong>24 hours</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colchicine</td>
<td>0.25%</td>
<td>7.20</td>
<td>66.80</td>
<td>7.30</td>
</tr>
<tr>
<td></td>
<td>0.50%</td>
<td>8.40</td>
<td>80.40</td>
<td>8.40</td>
</tr>
<tr>
<td></td>
<td>0.75%</td>
<td>7.20</td>
<td>68.80</td>
<td>7.10</td>
</tr>
<tr>
<td></td>
<td>1.00%</td>
<td>5.60</td>
<td>54.20</td>
<td>6.62</td>
</tr>
<tr>
<td><strong>48 hours</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colchicine</td>
<td>0.25%</td>
<td>5.40</td>
<td>52.80</td>
<td>6.72</td>
</tr>
<tr>
<td></td>
<td>0.50%</td>
<td>15.60</td>
<td>304.80</td>
<td>13.82</td>
</tr>
<tr>
<td></td>
<td>0.75%</td>
<td>9.60</td>
<td>166.60</td>
<td>9.90</td>
</tr>
<tr>
<td></td>
<td>1.00%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>72 hours</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colchicine</td>
<td>0.25%</td>
<td>6.60</td>
<td>62.40</td>
<td>6.40</td>
</tr>
<tr>
<td></td>
<td>0.50%</td>
<td>9.20</td>
<td>107.00</td>
<td>8.10</td>
</tr>
<tr>
<td></td>
<td>0.75%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1.00%</td>
<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>
It can thus be concluded that instead of inducing complete polyploidy, the colchicine produced gene mutation, resulting in gigas habit in the treated plants. Such colchicine induced mutation without any change in the chromosome number have been reported in other crops by Krishnaswamy et al. (1954), Solanki and Parmeshwarappa (1968) and Sanders and Franzke (1969).

SUMMARY

Attempts were made to evolve new varieties of iris through hybridization and induction of mutation and polyploidy. The important findings are summarised below:

1) Heterosis was manifested over better parent in respect of growth and flower quality of hybrids obtained from the intergeneric cross between Horsesh iridiodes (MI) and Iris aurea (IA). The hybrids from the cross between I. aurea x M. Iridiodes also showed improvement in flower quality though to a lesser extent than the hybrid obtained from MI x IA cross. The hybrids from the cross between Iris sibirica (IS) and I. florentina (IF) also exhibited heterosis in respect of growth and flower size over mid-parents. In contrast, hybrids from IF x IS cross made stunted growth and showed no improvement in flower quality. Out of 4 hybrids, the one obtained from cross MI x IA
proved to be best for hardy growth and flowers of excellent quality.

ii) Rhizomes of *Iris tectorum* and plantlets of *Iris graminea* were treated with different concentrations of ethyl-methane-sulphorlate (EMS) at varying levels of pH for 24 hrs. Changes in growth and flowering habit of plants in M₁ generation were recorded. The frequency of viable mutation was very high in 0.5 per cent EMS-treated *Iris tectorum* and *Iris graminea*. 0.50 per cent EMS at pH 9.2 resulted in appreciable improvement in growth, flowering and rhizome production in both species of *Iris* tested here. EMS at higher concentration (1.0 per cent) was mostly ineffective.

iii) Rhizomes of *Iris tectorum* were irradiated with gamma rays of doses 100 r, 200 r, 300 r, 400 r and 1000 r. The results indicated that with the increase in doses from 300 r, there was decrease in growth and flowering. Mutation frequency varied with the dose of gamma-rays. The maximum number of mutants were found at 200 r, followed by 300 r.

Besides affecting growth and flower number, gamma radiation resulted in variation in colour and form of flowers. These mutants were isolated at grown for studying their performance under Indian condition. It is expected that these will find a place in the varietal improvement programme of *Iris*. 
iv) Rhizomes of *I. tectorum* and plantlets of *I. germanica*, were treated with different concentrations of calchicine. Colchicine at a concentration of 0.50 per cent was found to be very effective in stimulating vegetative growth and promoting flowering in both species of *Iris* studied here. The highest yield of rhizomes was also recorded in 0.50 per cent colchicine treated plants. Soaking of rhizomes of *I. tectorum* in high concentration (0.75 or 1.00 per cent) of colchicine for 48 or 72 hours was found to be lethal. Cytological study revealed normal pairing of chromosomes and cell division in colchicine treated plants.

**LITERATURE CITED**


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1977. Application of gamma rays to cormels of different sizes of the gladiolus cultivar Peter Pears and the effect on the plants. *Scientific*, 5, 306-316.

* Original not consulted