Effect of EMS and SA on pollen sterility in M1 generation of Winged bean

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Abstract

In the present work, the seeds of winged bean (Psophocarpus tetragonolobus (L.) DC.) of variety II-EC-178315 and 2I-EC-38825 were treated with two chemical mutagens namely Ethyl Methane Sulfonate (EMS) and Sodium azide (SA) to induce mutations. After mutagenic treatments, a general trend towards increased pollen sterility with increasing concentration of EMS and SA could be observed in both the varieties of winged bean. The main objective of this particular study is to develop improved varieties of winged bean so that it can be popularized and cultivated all over the world.

Keywords: Pollen sterility, EMS, SA, Chemical mutagens and Winged Bean.

Introduction

Grain legumes occupy an important position in world agriculture by virtue of their high protein content, low cost of production and capacity for fixing atmospheric nitrogen. The only practical means of solving the protein malnutrition in developing countries like those in the Southeast Asia, where the majority of the population depends for its protein requirement on plant-to-man food chain, is to increase the production of grain legumes. The protein of grain legume is nutritionally important as a supplement to cereal protein. Thus it has become necessary to study in depth the neglected or little known legume species which are underexploited but which possess great potential for contributing to not only protein rich food for humans but also excellent feed and forage for animals. Among such group of plants, the ‘winged bean’ (Psophocarpus tetragonolobus (L.) DC.) stands outstanding. Winged bean is a potential new source of protein for the humid tropics. Perhaps the most important product of winged bean is the mature seed which will play a vital role in the development of the bean as food. The seed contains a high proportion of protein 29 - 42% (NAS, 1981). The seeds are similar in composition to soybean averaging 20% edible oil with a good proportion of polyunsaturated fatty acids Claydon (1978). The most impressive feature of winged bean tubers is their protein content. Cassava averages one percent protein and potatoes, sweet potatoes and yams 3 - 7% proteins, whereas, the winged bean tuber averages 20% protein (Haq, 1983).
From the above account it would clear that although several positive attributes are possessed by the winged bean, it is amazing still that the crop has remained obscure and neglected all over the globe. The farmers are still harvesting the same yield as in the past, neither any additional land has been brought under this crop over the years. Though this ‘Miracle bean’ has a chemical composition similar to or even better than soybean, such situation might have arisen due to some peculiar shortcomings possessed by the winged bean plant, which could have obstructed its wide scale popularization and ready usage the world over. Some, such shortcomings are the labour intensive nature of the crop, long duration of its life cycle and antinutritional factors in its seeds/tubers. To overcome these negative properties the conventional breeding programme is not enough. We have to make many changes in the genetic make-up of the species. One way to get all these desirable attributes is the mutation breeding. Thus the approach of the induced mutation breeding programme is applied in this pertinent study to develop desirable varieties of winged bean.

Materials and Methods

The seed material of winged bean (*Psophocarpus tetragonolobus* (L.) DC.) of variety, namely II-EC-178313 and 2I-EC-38825 were obtained from the National Bureau of Plant Genetic Resources, Regional Station, PKV, Akola. The chemical mutagens such as Ethyl Methane Sulfonate (EMS) and Sodium azide (SA) was used in the present study.

Details of Mutagenic Treatments

The pilot experiments were conducted for determining the suitable concentrations for further studies.

Prior to mutagenic treatments seeds were immersed in distilled water for 6 hr. The presoaking enhances the rate of uptake of the mutagen through an increase in cell permeability and also initiates metabolism in the seeds for treatment. Such presoaked seeds were later on immersed in the mutagenic solution for 6 hr with an intermittent shaking seeds soaked in distilled water for 12 hr served as control.

The different concentrations used for the chemical mutagenic treatments were 0.05%, 0.10% and 0.15% for EMS and 0.01%, 0.02% and 0.03% for SA respectively. Immediately after completion of treatment the seeds were washed thoroughly under tap water. Later on they were kept for post soaking in distilled water for 2 hr. After the completion of treatment, the seeds were sown in the field to raise M1 generation.

Pollen sterility was determined from 10 randomly selected plants belonging to each treatment. The pollen grains from freshly dehisced anthers were stained with 1% acetocarmine. Pollen grains that stained fully were counted as fertile, while the empty, partially stained and shriveled ones were considered as sterile.

Results and Discussion

A general trend towards increased pollen sterility with increasing concentration of EMS and SA could be observed in variety II-EC-178313 and in variety 2I-EC-28825 of winged bean (Table 1 and 2).

In case of control, 5.55% pollen in II-EC-178313 varietal material 4.44% pollen in 2I-EC-38825 variety of winged bean was observed to be sterile. The maximum pollen sterility (22.66%) could be seen at 0.15% concentration of EMS in variety II-EC-178313, while in variety 2I-EC-38825 the maximum pollen sterility (18.18%) could be seen at 0.03% concentration of SA.

The pollen sterility values ranged from 12.94 % to 22.66% and 11.25% to 17.64% after EMS and
13.95% to 22.22% and 11.76% to 18.18% after SA treatments in II-EC-178313 and 2I-EC-38825 varieties of winged bean, respectively.

In the present work, it is observed that the pollen sterility increased linearly with an increase in concentration of EMS/SA in both the varieties of winged bean. Similarly the induced pollen sterility by chemical mutagens has been noted by Froese-Gertzen et al. (1964), Gaul et al. (1966), Sato and Gaul (1967) and Gohal et al. (1972) in different plant systems. According to Kivi (1962), the sterility in M1 generation is indicative of the genetical effectiveness of the mutagenic treatment. As per the opinion of Sparrow (1951) the mutagen induced alterations in the reproductive potential are mainly due to inhibition of growth, sterile flowers, abortive pollen grains and embryo sac.

Konzak et al. (1961) and Sparrow and Woodwell (1962) stated that the major cause of pollen sterility could be chromosomal abnormalities. According to Nilan et al. (1964) gross injury due to gene controlled biochemical processes or acute chromosomal aberrations or both may be the reasons for pollen sterility. Bora et al. (1961) are of the opinion that the high pollen sterility is due to the inversion and other chromosomal abnormalities such as non-orientation of chromosomes at metaphase II and laggards at anaphase II.

### Table – 1. Effect of EMS on pollen sterility in M1 generation of *Psophocarpus tetragonolobus* (L.) DC.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Concentration</th>
<th>Pollen sterility (%)</th>
<th>± S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>II-EC-178313</td>
<td>Control</td>
<td>5.55</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>0.05 %</td>
<td>12.94</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>0.10 %</td>
<td>17.50</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>0.15 %</td>
<td>22.66</td>
<td>0.88</td>
</tr>
<tr>
<td>2I-EC-38825</td>
<td>Control</td>
<td>4.44</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>0.05 %</td>
<td>11.25</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>0.10 %</td>
<td>13.33</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>0.15 %</td>
<td>17.64</td>
<td>0.57</td>
</tr>
</tbody>
</table>

± S.E. = Standard Error

### Table – 2. Effect of SA on pollen sterility in M1 generation of *Psophocarpus tetragonolobus* (L.) DC.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Concentration</th>
<th>Pollen sterility (%)</th>
<th>± S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>II-EC-178313</td>
<td>Control</td>
<td>5.55</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>0.01 %</td>
<td>13.95</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>0.02 %</td>
<td>17.72</td>
<td>1.73</td>
</tr>
<tr>
<td></td>
<td>0.03 %</td>
<td>22.22</td>
<td>1.45</td>
</tr>
<tr>
<td>2I-EC-38825</td>
<td>Control</td>
<td>4.44</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>0.01 %</td>
<td>11.76</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>0.02 %</td>
<td>14.63</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>0.03%</td>
<td>18.18</td>
<td>1.20</td>
</tr>
</tbody>
</table>

± S.E. = Standard Error
In the present study both the varieties of winged bean showed minor differences in regard to the parameter of pollen sterility. Singh and Chowdhary (1972) reported varietal sensitivity in two varieties of guar. Siddiq (1973) studied the relative effect of physical and chemical mutagens pertaining to cytological behavior and pollen sterility in two varieties of rice. He found that Japonica variety was more sensitive than the variety indica.

In the present work the high pollen sterility may have been due to meiotic abnormalities recorded in II-EC-178313 and 2I-EC-38825 varieties of winged bean.

**Conclusion**

The percentage of pollen sterility was found on the increasing side with the increasing concentration of both the mutagens in II-EC-178313 and 2I-EC-38825 varieties of winged bean.

**References**


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