Inheritance of Gynoecism in Bitter Gourd (Momordica charantia L.)

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The inheritance of sex expression in cucumber (Cucumis sativus) and other cucurbits is well documented; however, the genetics of female sex (gynoecism) expression in bitter gourd (Momordica charantia) has not been described. Inheritance of gynoecism in bitter gourd was studied in a 100% gynoecious line (Gy263B). The F2 and testcross segregation data revealed that gynoecism in Gy263B is under the control of a single, recessive gene. Following the gene nomenclature of cucurbits, it is proposed that the gene symbol, gy-1, be assigned for the expression of gynoecism in bitter gourd.

Bitter gourd, balsam pear, bitter melon, or bitter cucumber (Momordica charantia) is an important cucurbitaceous vegetable. Fruits of bitter gourd are widely consumed as a vegetable and are well known for its antidiabetic and other medicinal properties (Robinson and Decker-Walters 1997). Bitter gourd originated in the Old and New Worlds (Bates et al. 1995). It is among the most popular cucurbits and has very wide commercial distribution in India. In cucurbits, several flowering habits (sex forms) like monoecious, gynoecious, andromonoecious, androgynoecious, gymomonooecious, etc. have been described (Kalloo 1988; Robinson and Decker-Walters 1997). Gynoecious flowering habit is characterized by the presence of only pistillate flowers on a plant.

Inheritance of gynoecism (femaleness) has been well documented in cucumber, and gynoecious lines are commercially used for cost effective hybrid seed production (Kalloo 1988; Kumar and Singh 2004; Robinson et al. 1976). In melon (Cucumis melo L.), a single recessive gene for gymonomoeeic (mostly pistillate flowers and a few hermaphrodite/perfect flowers) is known (Poole and Grimball 1939). However, in bitter gourd, occurrence of gynoecism is very rare. An extensive literature survey found only three reports (Ram et al. 2002a,b; Zhou et al. 1998) of gynoecism occurring in bitter gourd. For the first time, bitter gourd plants with a complete expression of gynoecious flowering habit (only pistillate flowers on a plant) have been located (Ram et al. 2002a). Several populations with a very high proportion (more than 90%) of pistillate flowers have been developed (Ram et al. 2002b). A genetic analysis of the inheritance of gynoecism in bitter gourd was performed and is presented in this short communication.

Materials and Methods

In 2002, an inbred derived from an improved monoecious population (Pusa Do Mosami) was used as male parent to develop cross on a gynoecious line, Gy263B. Gy263B line was previously found in a germplasm population, IC68263B, and has been maintained through sibmating with monoecious plants of the same population (Ram et al. 2002a,b). In 2003, the F1 population and both parents were grown. One F1 plant was selfed using staminate flower from the same plant to obtain fruits containing F2 seeds. The staminate flowers from the same plant were used to pollinate pistillate flowers of the gynoecious plants to obtain the testcross progeny. The progenies of the F1, F2 (developed from two selfed fruits), and the testcross population were grown in 2004. All plants were observed for the presence of pistillate and staminate flowers throughout the growing season. Based on flowering habit, individual F2 and testcross plants were classified as gynoecious or and/or monoecious. The data from the F2 and the testcross populations were analyzed using the chi square for goodness-of-fit based on a monogenic recessive control of gynoecism. The Gy263B population segregating for gynoecious and monoecious plants was characterized for the following horticultural traits: days to anthesis, first pistillate flower node, spine length, vine length, days to physiological maturity, and days to commercial maturity. The observations were recorded on 10 monoecious and 10 gynoecious plants for two consecutive seasons (2002 and 2003). The means of the various horticultural traits from the gynoecious and the monoecious plants were statistically compared using Student’s unpaired t test.

Results and Discussion

Seeds of the parental lines, Gy263B and Pusa Do Mosami, the F1, the F2, and the testcross populations were sown under open field conditions, and a healthy crop stand was obtained.
The F1 population was monoecious, while the F2 and testcross populations segregated for gynoecism. The F2 progenies, derived from two selfed fruits, had 36 and 50 plants, respectively. These two F2 progenies segregated in a 25 monoecious:11 gynoecious and a 33 monoecious:17 gynoecious ratio (Table 1), respectively. The testcross progenies, derived from two fruits, had 31 and 33 plants, respectively. The testcross progenies segregated 13 monoecious:18 gynoecious and 14 monoecious:19 gynoecious plants (Table 1), respectively. The F2 progeny was pooled, and the segregation ratio showed a good fit to a 3 monoecious:1 gynoecious plants (Table 1). The expected ratio of the testcross would be 1 monoecious:1 gynoecious, and the results of the chi-square analysis indicated a good fit to a 1:1 ratio (Table 1).

The F2 and the testcross segregation data revealed that in the Gy263B line, gynoecism is under the control of a single recessive gene. In accordance with cucurbits gene nomenclature (Robinson et al. 1976), a gene symbol gyn-1 is proposed for the expression of gynoecism in bitter gourd.

In cucumber, a recessive gene for gynoecious sex expression was induced through mutation, which has been found to be linked and interact with a dominant gene Int-F (intensifier for female sex), leading to higher degree of pistillate sex expression (Robinson et al. 1976). In melon, genes a (andro-monoecious) and g (gynomonoecious) interact to influence sex expression, and stable gynoecism can be achieved (Robinson and Decker-Walters 1997).

The gynoecious plants of Gy263B had significantly longer (200 cm) vine length than their monoecious counterparts (127.5 cm) (data not presented). There were no significant differences between the gynoecious and monoecious plants for the remaining horticultural traits. This was expected because the Gy263B population is maintained through consecutive sibbing to the monoecious plants (Ram et al. 2002b). Fruits were light green, attractive, 12.8 cm long, with a 3.4-cm girth, light tubercle, and an average weight of 60 g. Hence Gy263B possesses all desirable attributes and could directly be utilized as a parent for F1 hybrid development of bitter melon.

Acknowledgments

Critical suggestions with respect to improving the clarity of the manuscript given by Prof. P.W. Bosland of New Mexico State University, Las Cruces, United States, and technical assistance provided by Mr. Arun Kumar of Indian Institute of Vegetable Research, Varanasi, are thankfully acknowledged.

References


Table 1. Chi-square (χ²) analysis for goodness-of-fit to a 3:1 (F2) and 1:1 (testcross) ratio of inheritance of the gynoecious (Gyn.) and monoecious (Mon.) phenotype between Gy263B and Pusa Do Mosami

<table>
<thead>
<tr>
<th>Generation</th>
<th>Observed ratio (Mon.:Gyn.)</th>
<th>Expected ratio (Mon.:Gyn.)</th>
<th>χ²</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2 (fruit #1)</td>
<td>25:11</td>
<td>3:1</td>
<td>0.59</td>
<td>.44</td>
</tr>
<tr>
<td>F2 (fruit #2)</td>
<td>33:17</td>
<td>3:1</td>
<td>2.16</td>
<td>.14</td>
</tr>
<tr>
<td>F2 (pooled)</td>
<td>58:28</td>
<td>3:1</td>
<td>2.62</td>
<td>.11</td>
</tr>
<tr>
<td>Testcross (fruit #1)</td>
<td>13:18</td>
<td>1:1</td>
<td>0.81</td>
<td>.37</td>
</tr>
<tr>
<td>Testcross (fruit #2)</td>
<td>14:19</td>
<td>1:1</td>
<td>0.76</td>
<td>.38</td>
</tr>
<tr>
<td>Testcross (pooled)</td>
<td>27:37</td>
<td>1:1</td>
<td>1.56</td>
<td>.21</td>
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</table>

Received July 8, 2005
Accepted January 29, 2006

Corresponding Editor: J. Perry Gustafson