Full Length Research Paper

Gene action studies on yield and quality traits in okra (Abelmoschus esculentus (L.) Moench)

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Selection of suitable breeding methodologies in bringing desirable improvement in crop plant require the complete knowledge about the nature of gene action involved in the inheritance of quantitative and quality traits. Gene action of fruit yield and quality traits in okra (Abelmoschus esculentus (L.) Moench) were studied through half diallel analysis of 28 F1 hybrids derived by crossing 8 parental lines. The present study indicated the preponderance of non-additive gene action for days to 50% flowering, nodes per plant, fruit length, fruit diameter, plant height, fruits per plant and mucilage and a preponderance of additive gene action for days to first picking, first fruit producing node, internodal length, average fruit weight and harvest duration. For fruit yield per plant and dry matter, only dominant component of variance was observed which revealed the presence of non-additive gene action, hence, heterosis breeding is required to be followed for exploitation of these traits.

Key words: Gene action, okra, variance, diallel, fruit yield.

INTRODUCTION

Okra (Abelmoschus esculentus (L.) Moench) is a warm season vegetable in the tropical and subtropical countries of the world. It is native of Ethiopia (Vavilov, 1951). The immature young seed pods are the edible part of this plant, which are consumed as cooked vegetable, mostly fresh but sometimes sun-dried. Okra is gaining importance with regard to its nutritional, medicinal, and industrial value. Apart from nutritional and health importance, okra plays an important role in income generation and subsistence among rural farmers in developing countries like India. It has a vast potential as one of the foreign exchange earner crops and accounts for 70% of the export of fresh vegetables excluding potato, onion and garlic, the destinations being the Middle East, Western Europe and USA. It is commercially grown in the Indian states of Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. The prominent position of okra among Indian vegetables can be due to its easy cultivation, dependable and regular yield, wider adaptability and year round cultivation. In spite of its importance, no major breakthrough has been made in this crop and the farmers are still growing their own local varieties or open pollinated varieties. Hence, there is a need for restructuring this vegetable crop for increasing the productivity.

Knowledge on the genetic system controlling the quantitative and quality traits is important for formulating an efficient selection program through the use of a suitable mating design. The information about the relative contribution of components of variation viz., additive and...
non-additive, is essential for effective crop improvement program (Azhar and Ajmal, 1999). In order to apply an optimum breeding strategy for targeted quantitative and quality traits, a genetic analysis of those traits needs to be performed. Diallel mating design has been used extensively by several researchers to measure gene action for yield and yield components in okra (Jindal et al., 2009; Singh et al., 2009). Several workers studied gene action of the yield and yield attributes and determined that additive and non-additive variance components are important in the genetic control of yield and its associated traits in okra (Jaiprakashnarayan et al., 2008; Singh et al., 2009). The present investigation was, therefore, undertaken with a set of half-diallel crosses to elicit information about the nature and magnitude of gene action for yield and its components in okra so as to formulate suitable breeding strategy.

MATERIALS AND METHODS

Eight okra genotypes viz., P-20, 9801, VRO-4, Parbhani Kranti (PK), P-8, Hisar Unnat (HU), Tulsi-I and SKBS-11 were chosen in this study to represent substantial amount of genetic diversity for different quantitative and quality traits and were maintained through selfing during 2011. These eight genotypes were involved in 8 × 8 half-diallel combinations to develop 28 F1 hybrids during 2012. All the F1’s along with their parents were evaluated in a Randomized Block Design with three replications during summer-rainy season of 2013 at Experimental Farm of the Department of Vegetable Science and Floriculture, CSKHPKV, Palampur. The crop was raised in three rows of 2.5 m length with inter and intra row spacing of 45 and 15 cm, respectively. Standard agronomic practices were followed and plant protection measures were taken as and when required. The observations were recorded on five competitive plants in each entry and replication for the parameters viz., days to 50% flowering, days to first picking, first fruit producing node, nodes per plant, internodal length, fruit length, fruit diameter, average fruit weight, plant height, harvest duration, fruits per plant, fruit yield per plant, dry matter and mucilage. For analysis of variance, days to first picking, first fruit producing node, nodes per plant, internodal length, fruit length, fruit diameter, average fruit weight, plant height, harvest duration, fruits per plant, fruit yield per plant, dry matter and mucilage were presented in Table 1. Analysis of variance reported significant differences for all the traits studied except dry matter and revealed that sufficient genetic variability was generated for yield and related traits after crossing eight diverse genotypes of okra in a diallel mating design (excluding reciprocals).

Analysis of variance

The analysis of variance carried out for different traits of okra, viz., days to 50% flowering, days to first picking, first fruit producing node, nodes per plant, internodal length, fruit length, fruit diameter, average fruit weight, plant height, harvest duration, fruits per plant, fruit yield per plant, dry matter and mucilage are presented in Table 1. Analysis of variance reported significant differences for all the traits studied except dry matter and revealed that sufficient genetic variability was generated for yield and related traits after crossing eight diverse genotypes of okra in a diallel mating design (excluding reciprocals).

Estimates of genetic components of variance

The nature of gene action has been inferred from the estimates of GCA and SCA variances. The estimates of combining ability variances (σ2gca and σ2sca) and the ratio of σ2A/σ2D have been presented in Table 2. The values of σ2sca ranged from 0.016 (mucilage) to 507.988 (fruit yield per plant), while σ2gca ranged from -5.483 (fruit yield per plant) to 68.226 (plant height). The estimates of σ2sca were higher in magnitude as compared to σ2gca for all the characters except for first fruit producing node and harvest duration. The preponderance of σ2sca revealed the predominant role of non-additive gene action governing these traits.

In the present investigation, the comparative estimates of σ2sca, σ2gca, σ2A, σ2D and σ2A/σ2D revealed that non-additive gene action is controlling the expression of days to 50% flowering, nodes per plant, fruit length, fruit diameter, plant height, fruits per plant and mucilage. For fruit yield per plant and dry matter, only dominant component of variance (σ2D) was observed which indicated the presence of non-additive gene action, hence, heterosis breeding is required to be followed for exploitation of these traits. The traits viz., days to first picking, first fruit producing node, internodal length, average fruit weight and harvest duration are controlled by additive gene action, as the ratio σ2A/σ2D is greater than 1.
Table 1. Analysis of variance for quantitative and quality traits in okra.

<table>
<thead>
<tr>
<th>Traits</th>
<th>Mean squares</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sources</td>
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<tr>
<td></td>
<td>df</td>
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<tr>
<td>Quantitative traits</td>
<td></td>
</tr>
<tr>
<td>Days to 50% flowering</td>
<td>1.676</td>
</tr>
<tr>
<td>Days to first picking</td>
<td>8.951</td>
</tr>
<tr>
<td>First fruit producing node</td>
<td>0.073</td>
</tr>
<tr>
<td>Nodes per plant</td>
<td>0.100</td>
</tr>
<tr>
<td>Internodal length (cm)</td>
<td>0.259</td>
</tr>
<tr>
<td>Fruit length (cm)</td>
<td>0.209</td>
</tr>
<tr>
<td>Fruit diameter (cm)</td>
<td>1.201</td>
</tr>
<tr>
<td>Average fruit weight (g)</td>
<td>0.073</td>
</tr>
<tr>
<td>Plant height (cm)</td>
<td>108.193</td>
</tr>
<tr>
<td>Harvest duration (days)</td>
<td>14.074</td>
</tr>
<tr>
<td>Fruits per plant</td>
<td>1.715</td>
</tr>
<tr>
<td>Fruit yield per plant (g)</td>
<td>117.264</td>
</tr>
<tr>
<td>Quality traits</td>
<td></td>
</tr>
<tr>
<td>Dry matter (%)</td>
<td>0.623</td>
</tr>
<tr>
<td>Mucilage (%)</td>
<td>0.009</td>
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</tbody>
</table>

*Significant at 5% level.

Table 2. Variance due to general and specific combining ability and their ratio for different quantitative and qualitative traits in okra.

<table>
<thead>
<tr>
<th>Components</th>
<th>σ²gca</th>
<th>σ²sca</th>
<th>σ²A</th>
<th>σ²D</th>
<th>σ²A/σ²D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative traits</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Days to 50% flowering</td>
<td>0.593</td>
<td>1.840</td>
<td>1.187</td>
<td>1.840</td>
<td>0.645</td>
</tr>
<tr>
<td>Days to first picking</td>
<td>0.816</td>
<td>1.535</td>
<td>1.632</td>
<td>1.535</td>
<td>1.063</td>
</tr>
<tr>
<td>First fruit producing node</td>
<td>0.026</td>
<td>0.019</td>
<td>0.052</td>
<td>0.019</td>
<td>2.737</td>
</tr>
<tr>
<td>Nodes per plant</td>
<td>0.053</td>
<td>0.670</td>
<td>0.107</td>
<td>0.670</td>
<td>0.160</td>
</tr>
<tr>
<td>Internodal length (cm)</td>
<td>0.338</td>
<td>0.647</td>
<td>0.677</td>
<td>0.647</td>
<td>1.046</td>
</tr>
<tr>
<td>Fruit length (cm)</td>
<td>0.040</td>
<td>0.156</td>
<td>0.080</td>
<td>0.156</td>
<td>0.513</td>
</tr>
<tr>
<td>Fruit diameter (cm)</td>
<td>0.235</td>
<td>0.583</td>
<td>0.471</td>
<td>0.583</td>
<td>0.808</td>
</tr>
<tr>
<td>Average fruit weight (g)</td>
<td>0.110</td>
<td>0.167</td>
<td>0.220</td>
<td>0.167</td>
<td>1.317</td>
</tr>
<tr>
<td>Plant height (cm)</td>
<td>68.226</td>
<td>219.078</td>
<td>136.452</td>
<td>219.078</td>
<td>0.623</td>
</tr>
<tr>
<td>Harvest duration (days)</td>
<td>1.127</td>
<td>0.736</td>
<td>2.254</td>
<td>0.736</td>
<td>3.063</td>
</tr>
<tr>
<td>Fruits per plant</td>
<td>0.025</td>
<td>1.306</td>
<td>0.049</td>
<td>1.306</td>
<td>0.038</td>
</tr>
<tr>
<td>Fruit yield per plant (g)</td>
<td>-5.483</td>
<td>507.988</td>
<td>-10.965</td>
<td>507.988</td>
<td>-0.022</td>
</tr>
<tr>
<td>Quality traits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry matter (%)</td>
<td>-0.001</td>
<td>0.118</td>
<td>-0.003</td>
<td>0.118</td>
<td>-0.025</td>
</tr>
<tr>
<td>Mucilage (%)</td>
<td>0.000</td>
<td>0.016</td>
<td>0.001</td>
<td>0.016</td>
<td>0.063</td>
</tr>
</tbody>
</table>

σ²gca = general combining ability variance; σ²sca = specific combining ability variance; σ²A = additive component of variance and σ²D = dominant component of variance.

than unity. Hence, pedigree selection could be exploited for these traits. For the traits viz., days to first picking, internodal length and average fruit weight, where σ²sca is higher than σ²gca but, σ²D is less than σ²A. It suggests that the estimates of GCA variance include additive variance and also a portion of additive and higher order
epistatic interactions. Under such conditions, recurrent selections shall prove effective. These results of the present investigation are in conformity to the findings of Kachhadia et al. (2011), Parmar et al. (2012) and Kumar et al. (2014). However, contradictory reports are also available in literature with respect to gene action studies which can be due to different genetic material used in the present study. Since both additive and non-additive variances were found to be important in the genetic control of all quantitative and quality traits in the present study, the use of a population improvement method in the form of diallel selective mating or mass selection with concurrent random mating might lead to release of new varieties with higher yield in okra.

Conclusion

Sufficient genetic variability was generated for yield and related traits after crossing eight diverse genotypes of okra in a diallel mating design (excluding reciprocals). The presence of non-additive gene action revealed that heterosis breeding is required to be followed for further improvement of okra.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES


