Combining ability studies in cucumber (*Cucumis sativus* L.) in mid hills of Himachal Pradesh

**BS Dogra and MS Kanwar**

**Abstract**

For the development of superior hybrids, estimates of general combining ability of parents and specific combining ability of the crosses help in proper selection of parents for hybridization. The high estimates of gca were exhibited by K-90, G$_2$ and Gyn$_1$ for most of the characters. In general, there was a close agreement between gca effects and per se performance but in certain cases, it did not hold good which may be due to higher degree of gene action involved. The superior cross combinations which recorded high sca estimates and per se performance for yield and number of fruits were K-90 x G$_2$ and K-90 x Gyn$_1$ and hence, may be exploited for the development of F$_1$ hybrid (s) after testing their performance at multi-locations for 2-3 years.

**Keywords:** Cucumber, *Cucumis sativus*, gca, sca, hybrids

**Introduction**

Cucumber (*Cucumis sativus* L.), a member of family Cucurbitaceae is grown as summer and rainy season crop in low and mid hills of North-Western Himalaya from April to August and fruits are available from June to October to the plains. The crop raised in the hills being of high quality and off-season brings good returns to the growers. F$_1$ hybrids in cucumber as in many vegetable crops have several well known advantages over open-pollinated varieties and hence, provide a scope for the breeder to find out more appropriate combination to develop superior hybrids. The F$_1$'s are early, vigorous, high yielding, tolerant to diseases and insect-pests and more efficient in the use of water and fertilizers. Currently, the farmers are purchasing hybrid seeds from the private firms, who are charging exorbitantly. To tide over the situation, there is a need to make concentrated efforts to develop F$_1$ hybrids and making their seed available to the farmers at a reasonable price. For the development of superior hybrids, estimates of general combining ability of parents and specific combining ability of the crosses help in proper selection of parents for hybridization. Moreover, use of gynoecious lines for developing cucumber hybrids makes the production of F$_1$ seed more cost effective.

**Materials and Methods**

The present investigations were carried out at Experimental Farm of the Department of Vegetable Crops, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) which is 1276 m a.m.s.l. All the parents except two gynoecious lines were of monoecious type. Crosses among eight parents were attempted in a half-diallel fashion. The material comprised of eight parents, twenty eight F$_1$'s and one check (Pusa Sanyog) was sown in Randomized Block Design with three replications. Spacing was 1.25x1.00 m. Data were recorded on randomly selected plants for yield and horticultural characters. Griffing's [7] method II model I was used for deriving general and specific combining ability estimates. The analysis of variance for combining ability was based on following mathematical model:

$$ P_{ijk} = m + g_i + g_j + s_{ij} + b_k + e_{ijk} $$

Where,

- $P_{ijk}$ = phenotypes of the hybrids between i th and j th parents in k th plots
- $m$ = population mean
- $g_i$ = GCA effects of i th parent
- $g_j$ = GCA effects of j th parent
- $s_{ij}$ = SCA of the crosses between i th and j th parents
- $b_k$ = block effects
- $e_{ijk}$ = environmental effect associated with ijk th observation

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Results and Discussion

Analysis of variance (Table 1) for combining ability revealed that importance of gca ($\sigma^2_g$) was more than sca ($\sigma^2_s$) indicating the preponderance of additive gene action for days to first female flower appearance and days to marketable maturity. However, in all the other traits, sca component was higher in magnitude than gca one’s indicating the preponderance of non-additive gene effects in conformity with the findings of Naik et al. [12]. However, mean sum of squares for gca and sca were highly significant for all the characters except TSS suggesting the importance of both additive and non-additive genetic variance in consonance with the findings of Ene et al. [5]; Om et al. [13]; and Pradhan et al. [14].

The parents viz. G2, Gyn1, and Poinsette had negative estimates for days to first female flower appearance and node at which first female flower appears showing earliness in fruit bearing and were good general combiners for these characters. Among F1’s, the sca effects were significantly negative in 12 and 15 crosses, respectively for these two traits. The crosses LC-11 x Gyn1 (poor x high) and EC 173934 x LC-40 (poor x poor), respectively had highest sca effect for these traits. The parents viz. G2 and Gyn1 with significantly high gca estimates (with negative value) were good general combiners for days to marketable maturity. Crosses viz. LC-11 x Gyn1; EC 173934 x LC-40, K-90 x G2; and K-90 x EC 173934 had high sca estimates involving poor x high, medium x high and medium x poor general combining parental lines, respectively. El-Shawaf and Baker [13]; Om et al. [13]; and Wang and Wang [16] also reported greater additive genetic variance for days to marketable maturity. However, Malav et al. [11] reported the preponderance of non additive genes for this trait. The parents viz. G2 and Gyn1 may be used in the hybridisation programme for developing early hybrids. LC-11 x Gyn1 and EC 173934 x LC-40 may be exploited as early hybrids after further multilocational testing. These crosses may also be exploited to produce transgressive segregants in advanced generations.

For fruit length, the parents Gyn1, LC-11 and K-90 were good general combiners which was evident from their high gca estimates. 14 crosses exhibited significant sca effects. The sca effects were high in crosses Poinsette x LC-40 and G2 x Poinsette involving poor x poor general combiners. K-90, K-75 and EC 173934 had highest gca with respect to fruit width and hence were good general combiners. The sca effect was maximum in G2 x Gyn1 involving poor x poor general combing parental lines. Hormuzdi and More [9]; and Kupper and Staub [10] reported contrasting results for fruit length and width.

The best general combiners for TSS in order of merit were EC 173934 and LC-40. Among 28 specific combinations, 16 crosses exhibited positive sca effects being maximum in K-90 x Poinsette and Poinsette x K-75 involving poor x poor general combiners. For flesh to seed cavity ratio, the best general combiners were Poinsette, EC 173934 and Gyn1. Cross combination K-90 x K-75 had maximum sca among seven significant and positive specific combinations. In contradiction to the present results, importance of additive gene action for flesh to seed cavity was reported Dogra [11]. The parents LC-11, K-90 and K-75 depicted high per se performance w.r.t. fruit weight as evident from their high gca effect. These parents had maximum concentration of favourable genes for increasing fruit weight. Eleven specific cross combinations were having significantly positive sca effects being maximum in K-90 x LC-11 (high x high) and K-90 x EC 173934 (high x poor). Non-additive gene action for fruit weight was also obtained Ghaderi and Lower [6]; Malav et al. [11] in consonance with the present findings. However, Gyn1 and G2 were identified as good general combiners for number of fruits per plant. The top specific combination in order of merit were K-90 x G2, K-90 x Gyn1 and K-75 x Gyn1 involving midm x high, medium x high and poor x high general combiners, respectively. Importance of non additive gene action for number of fruits per plant was also reported Dogra [11]; Ghaderi and Lower [6]; and Om et al. [13]. However, the present results w.r.t. fruit weight and number of fruits are contrary to the findings of El Hafeez et al. [13] which may be due to difference in the parental material used for making diallel crosses.

For yield per plant, K-90 was the best general combiner in addition to Gyn1 and G2. The sca effects were high for K-90 x G2 (high x high), K-90 x Gyn1 (high x high) and LC-11 x Gyn1 (poor x high). Present results on yield per plant were similar to the earlier findings of Dolgib and Sidorova [2]; Ghaderi and Lower [6]; Om et al. [13]; and Wang and Wang [16] but in contradiction to the Gu et al. (8). F1 hybrid exhibited promising results when at least one of the parents with high gca for yield and contributing traits have been used in crosses thereby indicating the strong tendency of transmitting high potential from parents to off-springs Pradhan et al. [14]. The parents such as G2, Gyn1 and LC-40 had negative gca effects and were considered good general combiners for intermodal length. Nine specific combinations had significant negative value being maximum in K-90 x Poinsette and Poinsette x EC 173934 involving poor x poor general combiners. K-90, G2 and Gyn1 may be used in hybridisation for developing high yielding hybrids with more number of fruits per vine, long fruits and high TSS. Apparently, parents with good gca effect may be presumed to possess more favourable genes for the concerned traits. [Tiwari and Singh] [15]. The crosses viz. K-90 x G2 and K-90 x Gyn1 can be released as hybrids after further testing.

Table 1: Analysis of variance for combining ability for different characters in F1 cucumber

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Df</th>
<th>Days to first female flower appearance</th>
<th>Node of first female flower</th>
<th>Days to marketable maturity</th>
<th>Fruit length</th>
<th>Fruit width</th>
<th>TSS</th>
<th>Flesh to seed cavity ratio</th>
<th>Fruit weight</th>
<th>No. of fruits per plant</th>
<th>Yield per plant</th>
<th>Internodal length</th>
</tr>
</thead>
<tbody>
<tr>
<td>gca</td>
<td>7</td>
<td>678.818*</td>
<td>27.997*</td>
<td>705.436*</td>
<td>6.425*</td>
<td>1.087*</td>
<td>0.005</td>
<td>0.001*</td>
<td>3787.657</td>
<td>9.989*</td>
<td>0.735*</td>
<td>9.512*</td>
</tr>
<tr>
<td>sca</td>
<td>28</td>
<td>42.264*</td>
<td>3.049*</td>
<td>45.029*</td>
<td>3.237*</td>
<td>0.243*</td>
<td>0.021</td>
<td>0.0015*</td>
<td>693.149*</td>
<td>1.159*</td>
<td>0.193*</td>
<td>2.183*</td>
</tr>
<tr>
<td>Error</td>
<td>70</td>
<td>0.557</td>
<td>0.228</td>
<td>0.004</td>
<td>0.002</td>
<td>0.0013</td>
<td>0.0004</td>
<td>0.0001</td>
<td>632.357*</td>
<td>0.112</td>
<td>0.0013</td>
<td>0.272</td>
</tr>
<tr>
<td>$\sigma^2_g$</td>
<td>67.826</td>
<td>2.777</td>
<td>70.487</td>
<td>0.642</td>
<td>0.108</td>
<td>0.0004</td>
<td>0.0001</td>
<td>0.372.53</td>
<td>0.979</td>
<td>0.073</td>
<td>0.924</td>
<td>0.924</td>
</tr>
<tr>
<td>$\sigma^2_s$</td>
<td>41.707</td>
<td>2.821</td>
<td>44.467</td>
<td>3.0233</td>
<td>0.240</td>
<td>0.020</td>
<td>0.002</td>
<td>630.79</td>
<td>1.047</td>
<td>0.191</td>
<td>1.911</td>
<td>1.911</td>
</tr>
<tr>
<td>$\sigma^2_g/\sigma^2_s$</td>
<td>1.626</td>
<td>0.984</td>
<td>1.585</td>
<td>0.199</td>
<td>0.451</td>
<td>0.021</td>
<td>0.068</td>
<td>0.591</td>
<td>0.934</td>
<td>0.383</td>
<td>0.483</td>
<td>0.483</td>
</tr>
</tbody>
</table>

* Significant at 5 per cent level of significance
Table 2: Estimates of general combining ability of parents for different characters in cucumber

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Days to first female flower appearance</th>
<th>Node of first female flower</th>
<th>Days to marketable maturity</th>
<th>Fruit length</th>
<th>Fruit width</th>
<th>TSS</th>
<th>Flesh to seed cavity ratio</th>
<th>Fruit weight</th>
<th>No. of fruits per plant</th>
<th>Yield per plant</th>
<th>Internodal length</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-90</td>
<td>0.000</td>
<td>0.367</td>
<td>-0.550</td>
<td>0.361</td>
<td>0.364</td>
<td>-0.016</td>
<td>-0.0002</td>
<td>20.083</td>
<td>0.017</td>
<td>0.276</td>
<td>0.021</td>
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<tr>
<td>G2</td>
<td>-12.133</td>
<td>-2.567</td>
<td>-2.127</td>
<td>-0.414</td>
<td>-0.041</td>
<td>0.004</td>
<td>0.0004</td>
<td>-25.250</td>
<td>1.317</td>
<td>0.302</td>
<td>-1.856</td>
</tr>
<tr>
<td>Poinsette</td>
<td>-2.433</td>
<td>-0.767</td>
<td>-2.013</td>
<td>-0.105</td>
<td>-0.531</td>
<td>-0.031</td>
<td>0.014</td>
<td>-4.917</td>
<td>-0.217</td>
<td>-0.055</td>
<td>1.048</td>
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<tr>
<td>EC173934</td>
<td>8.167</td>
<td>1.633</td>
<td>8.517</td>
<td>-0.390</td>
<td>0.191</td>
<td>0.037</td>
<td>0.011</td>
<td>7.417</td>
<td>-0.617</td>
<td>-0.346</td>
<td>0.144</td>
</tr>
<tr>
<td>K-75</td>
<td>0.733</td>
<td>0.733</td>
<td>1.017</td>
<td>-0.050</td>
<td>0.320</td>
<td>-0.004</td>
<td>0.017</td>
<td>10.803</td>
<td>-0.017</td>
<td>0.024</td>
<td>1.084</td>
</tr>
<tr>
<td>LC-11</td>
<td>6.600</td>
<td>0.633</td>
<td>6.583</td>
<td>0.888</td>
<td>0.135</td>
<td>0.022</td>
<td>0.007</td>
<td>32.750</td>
<td>-0.783</td>
<td>-0.089</td>
<td>0.604</td>
</tr>
<tr>
<td>LC-40</td>
<td>9.800</td>
<td>2.007</td>
<td>9.950</td>
<td>-0.225</td>
<td>-0.008</td>
<td>0.005</td>
<td>0.005</td>
<td>-8.417</td>
<td>-1.283</td>
<td>-0.379</td>
<td>-0.593</td>
</tr>
<tr>
<td>Gyni</td>
<td>-10.733</td>
<td>-2.100</td>
<td>-11.117</td>
<td>1.425</td>
<td>-0.433</td>
<td>0.002</td>
<td>0.008</td>
<td>-16.917</td>
<td>1.583</td>
<td>0.268</td>
<td>-0.453</td>
</tr>
<tr>
<td>SE (gi)</td>
<td>0.221</td>
<td>0.141</td>
<td>0.222</td>
<td>0.019</td>
<td>0.013</td>
<td>0.011</td>
<td>0.0019</td>
<td>2.363</td>
<td>0.099</td>
<td>0.011</td>
<td>0.154</td>
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<tr>
<td>CDₑₑₑₑ (gi)</td>
<td>0.441</td>
<td>0.281</td>
<td>0.443</td>
<td>0.037</td>
<td>0.026</td>
<td>0.021</td>
<td>0.0038</td>
<td>4.658</td>
<td>0.197</td>
<td>0.022</td>
<td>0.307</td>
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</table>

* Significant at 5 per cent level of significance

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References


