MEASURING OF COMBINING ABILITY, HERITABILITY AND HETEROSIS IN OKRA (ABELMOSCHUS ESCULENTUS L.)

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Annotation: This research was carried out at the Farms in the Governorate Hasaka - Syria, four cultivars genetically diverse parental of Okra (De1, De2, Sh1 and Sh2) were crossed in all possible combinations employing half diallel mating design, during July 2018 product six hybreds (de1*de2, De1*Sh1,
Dee1*Sh2, De2*Sh1, De2*Sh2, Sh1*Sh2 were combered in 2019 season according by Randomized Complete Block design with three replications. And estemate the heterosis and General combining ability (GCA) and specific combining ability (SCA).

**Key words:** Okra, General combining ability (GCA), specific combining ability (SCA).

### ОЦЕНКА КОМБИНАЦИОННОЙ СПОСОБНОСТИ, НАСЛЕДУЕМОСТИ И ГЕТЕРОЗИСА ОКРЫ (ABELMOSCHUS ESCULENTUS)

**Аннотация:** Данное научное исследование было проведено на фермерском хозяйстве в городе Аль-Хасаке - Сирия. Четыре генетически различающихся родительских сорта окры (De1, De2, Sh1 и Sh2) были скрещены во всех возможных комбинациях с использованием метода полудиаллельного спаривания. В июле 2018 г. было получено 6 гибридов de1*de2, De1*Sh1, Dee1*Sh2, De2*Sh1, De2*Sh2, Sh1*Sh2. В 2019 г. по рандомизированному полноблочному плану с тремя репликациями. Была произведена оценка гетерозиса и общей (GCA) и специфической комбинационной способности (SCA).

**Ключевые слова:** Окра, общая комбинационная способность (GCA), специфическая комбинационная способность (SCA).

### 1. Introduction

Okra [Abelmoschus esculentus (L.) Moench] is one of the important vegetable crop, grown for its tender green pods in world. It's rich from many mineral (protin, calsioum, firon, charpohidrate, fat, and vitamins ....etc) [1, c. 197].

Okra is a polyploid, belonging to the family Malvaceae with 2n = 8x = 72 or 144 chromosomes and a self-pollinated crop, the occurrence of out crossing to an extent of 4–19% with the maximum of 42.2% is noticed with the insect assisted pollination [2, c. 173].
The combining ability is the important genetic tool, which provides a guideline for an assessment of the relative breeding potential of the parents or identifying the best combiners, which may be hybridized either to exploit heterosis [3, c. 212].

The magnitude of heterosis provides a basic idea about genetical diversity present in the material. It also helps to choose desirable parents for the development of superior F1 hybrids for exploiting hybrid vigour and Gene action for some of characteristics.

The half diallel crosses is one method was cost for produce hybreds and known the combining ability between cultivars or lines for product hybreds wishes have high yield and best component characters.

The combining ability is the important genetic tool, which provides a guideline for an assessment of the relative breeding potential of the parents or identifying the best combiners, which may be hybridized either to exploit heterosis or to accumulate fixable genes and determined of breeding value [3, c. 212].

The general combining ability and specific combining ability effects are the foundations for any fruitful breeding programme [4, c. 1007]. The common approach of selecting the parents on the basis of performance of their superior Combining ability [5, c. 485].

Al-Mfragy (2006) found that there is significant deferances between five okra cultivars in yield, fruit no./plant, plant height(cm) and LAI. And the heterosis was positive and significant for yield/plant (52%) and fruit no. (48%) [6, c. 158]. The heterosis and significant combining ability showed in yield and yield components [7, c. 162]. The variance of GCA and SCA for characters because gene action and action between genetic factors and envirommental factors [8, c. 162]. The heterosis for okra green yield was 62.12% [9, c. 32].

**Objective of Study:**
Several approaches are available for: 1) - Product of F1 and select the best hybreds; 2) - study the heterosis; 3) - study of general and spicific combining ability.

2. Materials and Methods:

Four cultivars genetically diverse parental of okra (De1, De2, Sh1 and Shh2) were crossed in all possible combinations employing half diallel mating design.

The present study was conducted at Al-Haska, during July 2018- 2019.

In the 2018 crossing the parent by used Half-diallel Cross, The crossing results 6 hybreds (p(p-1)): (de1*de2, de1*sh1, de1*sh2, de2*sh1, de2*sh2, sh1*sh2).

The soil analysis was (pH=7.9, Ec=1.3 mm/cm, selt (40), sand (19), (41).

In the second seaason (2019) the hybreds grow Syria recorded on randomized complete block design with three replication, planting distance of 60 cm x 30 cm was maintained. And add the 25 kg super phosphat, 46% Uria and 50% Potacum slphate.

The following quantitative traits viz., days to first flowering, plant height (cm), fruit length and diameter (cm), no.of fruit per plant, and fruit yield ton/ha. Heterosia and combining ability were computed by used of analysis of variance F test and LSD₀.₀₅ [10, c. 657].

Broad sense Heritability estimated by used formula: \( (\sigma^2_g / \sigma^2_p) \times 100 \) [11, c. 119].

Genetic Advance as percentage (GA %):

\[
GA\% = \frac{k\sigma^2_g}{\sigma^2_p} \times \frac{100}{X}
\]

Were k=2.06 in selectin density 5%

General and spisific ability were computed by fixed model 4 method [12, c. 463].
\[ S_g = \frac{1}{2} \sum_i \left( X_{ij} + X_{ij} \right)^2 - \frac{2}{p^2} X_{..}^2, \]
\[ S_i = \frac{1}{2} \sum_j \sum_i X_{ij} (X_{ij} + X_{ij}) - \frac{1}{p} \sum_i \left( X_{ij} + X_{ij} \right)^2 + \frac{1}{p^2} X_{..}^2, \]
\[ S_n = \frac{1}{2} \sum_i \sum_j X_{ij} (X_{ij} - X_{ij})^2. \]

The \( \sigma_{GCA}^2/\sigma_{SCA}^2 \) were used for determine the gene action
\[ \frac{\sigma_{GCA}^2}{\sigma_{SCA}^2} > 1 \text{ additive gene action} \]
\[ \frac{\sigma_{GCA}^2}{\sigma_{SCA}^2} < 1 \text{ non additive gene action} \]
\[ \frac{\sigma_{GCA}^2}{\sigma_{SCA}^2} = 1 \text{ additive and non additive gene action} \]

The Heterosis computed by used me parents:
\[ H(MP) = \frac{(F1 - MP)}{MP} \times 100 \]

3. Results and Discussion
In this study we puting the data in table1 showed some phynologic, phnotopic and yield of Okra, as soon as value of LSD in 5% probability levels.

Table 1.

<table>
<thead>
<tr>
<th>Genotype</th>
<th>First flowering</th>
<th>Plant hight(cm)</th>
<th>LAI</th>
<th>Fruit length(cm)</th>
<th>Fruit diameter (cm)</th>
<th>No. Of fruit/plant</th>
<th>Yield fruit (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>De1</td>
<td>72</td>
<td>165</td>
<td>5.6</td>
<td>4.87</td>
<td>7.3</td>
<td>38</td>
<td>5.561</td>
</tr>
<tr>
<td>De2</td>
<td>68</td>
<td>164</td>
<td>5.7</td>
<td>5.99</td>
<td>6.7</td>
<td>36</td>
<td>5.158</td>
</tr>
<tr>
<td>Sh1</td>
<td>75</td>
<td>180</td>
<td>6.8</td>
<td>6.21</td>
<td>4.7</td>
<td>34</td>
<td>5.297</td>
</tr>
<tr>
<td>Sh2</td>
<td>76</td>
<td>160</td>
<td>6.8</td>
<td>6.25</td>
<td>3.7</td>
<td>30</td>
<td>6.054</td>
</tr>
<tr>
<td>De1*De2</td>
<td>61</td>
<td>210</td>
<td>12.4</td>
<td>8.14</td>
<td>6.3</td>
<td>60</td>
<td>7.556</td>
</tr>
<tr>
<td>De1*Sh1</td>
<td>64</td>
<td>240</td>
<td>13.0</td>
<td>9.27</td>
<td>5.0</td>
<td>52</td>
<td>9.154</td>
</tr>
<tr>
<td>De1*Sh2</td>
<td>63</td>
<td>200</td>
<td>13.1</td>
<td>10.4</td>
<td>5.3</td>
<td>58</td>
<td>8.601</td>
</tr>
<tr>
<td>De2*Sh1</td>
<td>62</td>
<td>220</td>
<td>13.5</td>
<td>10.75</td>
<td>5.0</td>
<td>55</td>
<td>8.291</td>
</tr>
<tr>
<td>De2*Sh2</td>
<td>59</td>
<td>215</td>
<td>12.7</td>
<td>10.02</td>
<td>4.7</td>
<td>57</td>
<td>8.176</td>
</tr>
<tr>
<td>Sh1*Sh2</td>
<td>67</td>
<td>225</td>
<td>14.6</td>
<td>11.57</td>
<td>5.7</td>
<td>63</td>
<td>10.182</td>
</tr>
<tr>
<td>LSD0.05</td>
<td>2.4</td>
<td>4.1</td>
<td>0.4</td>
<td>0.9</td>
<td>0.2</td>
<td>2.8</td>
<td>0.120</td>
</tr>
</tbody>
</table>
3.1. First flowering

The significant differences showed in first flowering. The earlier hybrid was De2*Sh2 (59) days and the next hybrid was De2*Sh1 (62) days, but the later hybrid was Sh1*Sh2 (67) days.

![First Flowering graph](image1)

**Figure 1. First flower.**

3.2. Plant height (cm)

From table (1) there is significant differences between hybrids in the plant height. Increase the height showed in De1*Sh2 (240cm) but the shorter hybrid was De1*Sh2 (200 cm).

![Plant Height graph](image2)

**Figure 2. Plant height(cm).**
3.3. Leaf Area Index (LAI):

From table (1) there is significant differences between hybrids in the LAI and the best hybrid was Sh1*Sh2 (13.5) but decrease it in the hybrids De1*De2 and De2*Sh2 (12.4 and 12.7) respectively.

![Figure 3. Leaf Area Index (LAI).](image)

3.4. Fruit length (cm)

There is significant differences between hybrids in fruit length were increased significantly compared with other hybrids Sh1*Sh2 (11.57) cm where the hybrid De1*Sh2 and De2*Sh1 were 10.7 and 10.4 cm respectively.

![Figure 4. Fruit length (cm).](image)
3.5. Fruit diameter (cm)

There are significant differences between hybrids for fruit diameter. The range of fruit diameter was 4.7-6.3 cm for De2*Sh1 and De1*De2.

![Figure 5. Fruit diameter (cm).](image)

3.6. Number of fruit/plant

There is significant differences between hybrids for fruit no./plant. Of fruit was 57-63 fruits by De2*Sh2 and Sh1*Sh2.

![Figure 6. Fruit Number in plant.](image)
3.7. Green fruit yield (ton/ha)

The result showed that significant differences between hybrids but the yield increased in Sh1*Sh2 was its yield (10.182) ton/ha.

![Green fruit yield (ton/ha)](image)

**Figure 7. Green fruit yield (ton/ha).**

3.8. Heterosis

The result of statistical analysis showed that F1's exhibited significant heterosis for all characters. All hybrid gave the negative value for number of days to flowering, the high value was (-18.1) for De2*Sh2. The hybrid (Sh1*sh2) gave the highest heterotic value for the number of fruit per plant (72.7) and yield fruit (79.4). The hybrid (De1*Sh2) gave the highest value for the fruit length (87.1), the hybrid showed (Sh1*Sh2) highest value for the fruit diameter and the hybrid (De1*De2) gave the highest value for the LAI (119.4).

<table>
<thead>
<tr>
<th>Genotype</th>
<th>First flowering</th>
<th>Plant height (cm)</th>
<th>LAI</th>
<th>Fruit length (cm)</th>
<th>Fruit diameter (cm)</th>
<th>No. of fruit/plant</th>
<th>Yield fruit (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>De1*De2</td>
<td>-12.9</td>
<td>27.7</td>
<td>119.4</td>
<td>49.9</td>
<td>-10.0</td>
<td>62.2</td>
<td>41.0</td>
</tr>
<tr>
<td>De1*Sh1</td>
<td>-12.9</td>
<td>39.1</td>
<td>94.7</td>
<td>67.3</td>
<td>-16.7</td>
<td>44.4</td>
<td>68.6</td>
</tr>
<tr>
<td>De1*Sh2</td>
<td>-14.9</td>
<td>23.1</td>
<td>81.5</td>
<td>87.1</td>
<td>-3.0</td>
<td>70.6</td>
<td>48.1</td>
</tr>
<tr>
<td>De2*Sh1</td>
<td>-13.3</td>
<td>27.9</td>
<td>41.4</td>
<td>76.2</td>
<td>23.5</td>
<td>57.1</td>
<td>58.6</td>
</tr>
<tr>
<td>De2*Sh2</td>
<td>-18.1</td>
<td>32.7</td>
<td>-0.1</td>
<td>63.7</td>
<td>-9.7</td>
<td>72.7</td>
<td>45.9</td>
</tr>
<tr>
<td>Sh1*Sh2</td>
<td>-11.3</td>
<td>32.4</td>
<td>12.2</td>
<td>85.7</td>
<td>36.0</td>
<td>96.9</td>
<td>79.4</td>
</tr>
</tbody>
</table>
3.9. Combining Ability

The character wise estimates of general combining ability effects for each parent are presented in table 3 and indicate that the merit of the parents differs significantly for different characters. Direct that genetic diverse for these characters, and from $\sigma^2\text{GCA}/\sigma^2\text{SCA}$ showed that the additive gen action was effect for LAI, Capsule No./plant, and yield. However the nonadditive action effect for flowering, long and girth fruit, where the additive and nonadditive were effect to plant hight. Accept with Al-Mfargy (2006) results [6, c. 158].

<table>
<thead>
<tr>
<th>Characters</th>
<th>GCA$^2\sigma$</th>
<th>SCA$^2\sigma$</th>
<th>$\sigma^2\text{GCA}/\sigma^2\text{SCA}$</th>
<th>Gene action</th>
</tr>
</thead>
<tbody>
<tr>
<td>First flowering</td>
<td>*3.74</td>
<td>3.92</td>
<td>0.95</td>
<td>Non additive</td>
</tr>
<tr>
<td>Plant height(cm)</td>
<td>**60.3</td>
<td>60.2</td>
<td>1.00</td>
<td>Additive and non additive</td>
</tr>
<tr>
<td>LAI</td>
<td>*2.45</td>
<td>2.1</td>
<td>1.17</td>
<td>Additive</td>
</tr>
<tr>
<td>Fruit length</td>
<td>*2.13</td>
<td>24.00</td>
<td>0.09</td>
<td>Non additive</td>
</tr>
<tr>
<td>Fruit diameter</td>
<td>*3.72</td>
<td>4.11</td>
<td>0.91</td>
<td>Non additive</td>
</tr>
<tr>
<td>No. Of fruits/plant</td>
<td>*3.22</td>
<td>2.35</td>
<td>1.37</td>
<td>Additive</td>
</tr>
<tr>
<td>Green yield(ton/ha)</td>
<td>*29.36</td>
<td>21.35</td>
<td>1.38</td>
<td>Additive</td>
</tr>
</tbody>
</table>

3.10. Broad since Heritability

From table (4) Showed that, the GV less than phv and the highly heritability for plant hight and capsules No./plant (74.78 and 74.34) respectivily. The heritability for Green fruit yield (ton/ha) was meiatly equal (51.58) % put it was low for LAI (15.65) %.

On the other hand, the GA% was good development for Fruit length (17.37%) this is useffully for selection hybreds.
<table>
<thead>
<tr>
<th>Fruit length(cm)</th>
<th>0.88</th>
<th>1.25</th>
<th>70.40</th>
<th>17.37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit diameter(cm)</td>
<td>0.26</td>
<td>0.87</td>
<td>29.89</td>
<td>10.93</td>
</tr>
<tr>
<td>Fruit No./plant</td>
<td>4.65</td>
<td>6.26</td>
<td>74.34</td>
<td>3.17</td>
</tr>
<tr>
<td>Green fruit yield (ton/ha)</td>
<td>45.60</td>
<td>88.40</td>
<td>51.58</td>
<td>14.35</td>
</tr>
</tbody>
</table>

4. Conclusion:

1. The hybreds showed that earlier flowering than its parents
2. Highly haterosis for LAI
3. The capsules yield was highly 10.82 ton/ha for Sh1*Sh2
4. The genitic additive principle fr girth, long and No. Of Capsule
5. Highly h2 for flowering.

Recommendation:

1. Re crossing and testing the hybreds in other enveromint for knowleg genetic stability.
2. Care of the Sh1 and Sh2.
3. Experment onther cultivars for hybreds production

References


