HETEROSIS FOR YIELD AND ITS COMPONENTS OVER ENVIRONMENTS IN CASTOR (Ricinus communis L.)

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ABSTRACT
Investigation with 19 parents (4 cent per cent pistillate lines and 15 inbreds) and their 60 hybrids of castor produced through L x T was taken up over four environments (two seasons and two locations) to determine the extent of heterosis for seed yield and seven related traits and to identify the best heterotic crosses for commercial cultivation. The relative heterosis, heterobeltiosis and standard heterosis for seed yield per plant over environments ranged from 1.23 to 148.76, -9.29 to 118.63 and -23.94 to 84.75 per cent respectively. The hybrids LRES 17 x RC 1226, 240 X USSR 2 and JP 65 X JH 120 exhibited maximum seed yield (183.2 g, 162.7 g and 158.7 g per plant respectively) with maximum heterosis. The heterosis for seed yield appeared to be due to high manifestation of heterosis for length of primary raceme, racemes per plant, capsules per plant and 100-seed weight. Selection of crosses on the basis of per se performance with considerable per cent of heterosis would be more desirable.

KEY WORDS: Castor, Ricinus communis, Heterosis, Environment

Singh and Narayanan (1995) opined that in order to obtain accurate results the crosses have to be evaluated over multilocation for two or three years. Hence, the study was taken up under two locations and two seasons.

MATERIALS AND METHODS
The materials consisted of four cent percent pistillate lines and 15 inbreds of castor and their 60 hybrids produced in line x tester mating design. The parents and their hybrids were evaluated in RBD with three replications at two locations, viz., Oilseeds Research Station, Tindivanam (11°46'N.
Table 1. Range of heterosis, heterobeltiosis and standard heterosis over four environments for yield and related traits in castor

<table>
<thead>
<tr>
<th>Traits</th>
<th>Heterosis</th>
<th>Heterobeltiosis</th>
<th>Standard heterosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed yield per plant (g)</td>
<td>1.23 to 148.76</td>
<td>-9.29 to 118.93</td>
<td>-23.94 to 84.75</td>
</tr>
<tr>
<td>Days to 50% flowering</td>
<td>-23.84 to 26.37</td>
<td>-14.41 to 42.62</td>
<td>2.28 to 63.49</td>
</tr>
<tr>
<td>Plant height upto PR (cm)</td>
<td>-45.98 to 22.71</td>
<td>-64.82 to 4.32</td>
<td>-75.21 to -25.96</td>
</tr>
<tr>
<td>No.of nodes upto PR</td>
<td>-21.94 to 23.07</td>
<td>-33.53 to 19.32</td>
<td>-39.55 to -10.23</td>
</tr>
<tr>
<td>Length of PR</td>
<td>-43.93 to 94.22</td>
<td>-56.37 to 87.28</td>
<td>-57.85 to -7.43</td>
</tr>
<tr>
<td>Racemes per plant</td>
<td>-0.29 to 146.58</td>
<td>-12.55 to 141.55</td>
<td>18.39 to 62.72</td>
</tr>
<tr>
<td>Capsules per plant</td>
<td>-4.41 to 92.69</td>
<td>-13.71 to 90.54</td>
<td>-30.27 to 54.59</td>
</tr>
<tr>
<td>100 seed weight (g)</td>
<td>-25.37 to 24.06</td>
<td>-25.63 to 25.47</td>
<td>-31.39 to 5.31</td>
</tr>
</tbody>
</table>

PR - Primary raceme

79.46° NE, 45.6 m MSL, temperature range from 24.1°C to 31.7°C, annual rainfall of 1228.6 mm, sandy loam soil with 7.4 pH and Sugarcane Research Station, Cuddalore (12.56°N, 79.50°E, 4.60 m MSL, temperature range from 23.61°C to 32.80°C, annual rainfall of 1196.6 mm, sandy clay loam soil with 6.8 pH) in two seasons viz., Summer 1993 and Kharif 1993. Each entry was raised in two rows, accommodating 10 plants in each row. A spacing of 90 cm between rows and 45 cm between plants was adopted. Data were recorded on 10 randomly selected plants for eight quantitative traits (Table 1). The heterosis over mid parent, over better parent (heterobeltiosis) and over the best parent (standard heterosis) was calculated and expressed in per cent.

RESULTS AND DISCUSSION

Range of significant heterosis in per cent for respective traits pooled over environments is presented in Table 1. The degree of heterosis varied from cross to cross for all the traits studied in individual as well as pooled over environments. The seed yield per plant, number of racemes and number of capsules per plant were found to be the most heterotic traits. Dangaria et al. (1987) also recorded high heterosis for these traits.

Table 2. Number of significant heterotic, hybrids over mid parent (H1), better parent (H2) and best parent (H3) in individual and pooled over environment for yield and related traits in castor

<table>
<thead>
<tr>
<th>Traits</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>Pooled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed yield per plant (g)</td>
<td>52</td>
<td>44</td>
<td>33</td>
<td>57</td>
<td>51</td>
</tr>
<tr>
<td>Days to 50% flowering</td>
<td>35</td>
<td>16</td>
<td>27</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Plant height upto PR (cm)</td>
<td>29</td>
<td>44</td>
<td>60</td>
<td>59</td>
<td>60</td>
</tr>
<tr>
<td>No.of nodes upto PR</td>
<td>32</td>
<td>40</td>
<td>60</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>Length of PR (cm)</td>
<td>26</td>
<td>21</td>
<td>-</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>Racemes per plant</td>
<td>46</td>
<td>39</td>
<td>22</td>
<td>50</td>
<td>39</td>
</tr>
<tr>
<td>Capsules per plant</td>
<td>53</td>
<td>43</td>
<td>31</td>
<td>30</td>
<td>31</td>
</tr>
<tr>
<td>100 seed weight (g)</td>
<td>27</td>
<td>23</td>
<td>1</td>
<td>37</td>
<td>24</td>
</tr>
</tbody>
</table>

E1 - Summer season at Tindivanam
E2 - Summer season at Cuddalore
E3 - Kharif season at Tindivanam
E4 - Kharif season at Cuddalore
PR - Primary raceme

* - Negative significant hybrids
In pooled analysis over four environments, out of 60 crosses, positive significant heterosis, heterobeltiosis and standard heterosis for seed yield were recorded in 57, 50 and 38 crosses, respectively (Table 1). This suggested that most of the inbred lines had different genetic system of co-adapted genes which interacted and manifested heterosis for this complex trait.

Among the three parameters used to determine hybrid vigour, heterobeltiosis appears to be more reliable tool than relative heterosis and standard heterosis (Hayes et al., 1955). In respect of yield components, 53 crosses were heterotic for racemes per plant, 40 for capsules per plant, 27 for length of primary raceme and 22 for 100 seed weight.

All the hybrids that have shown high degree of heterosis for seed yield, also exhibited substantial relative heterosis, heterobeltiosis and standard heterosis for racemes per plant, capsules per plant and heterosis and heterobeltiosis for length of primary raceme and 100 seed weight (Table 3). The magnitude of heterosis was higher in hybrids involving JP 65 as female parent and JH 120, RC 1226 and USSR 2 as male parents.

Caster is generally grown in marginal lands in drought prone areas. For this reason, early maturing (short) duration genotypes, which can escape drought and give good yield even with less precipitation, are better suited. Apart from days to 50% flowering, the plant height and (Swarnalatha et al., 1984; Patel et al., 1984) and Paik and Dangaria, 1987). All the 60 crosses expressed negative heterosis for plant height, 30 for nodes up to primary raceme and 10 for days to 50% flowering. It suggested that there is a possibility of developing short duration and dwarf hybrids.

High heterosis is obtained with parents of diverse origin in the presence of adequate favorable environments and in the absence of mutual cancellation of components of heterosis. Generally parents with high order of expression of the characters when combined produced hybrids with high expression (Gilbert, 1958). This was not true in the present study, where the per se performance of the parents and the percentage heterosis of resultant hybrids were considered with best 10 hybrids mentioned (Table 3). Among the parents, LRES 17, and RC 913 recorded the highest seed yield but the yield increase in terms of heterosis.

<table>
<thead>
<tr>
<th>Crosses</th>
<th>Seed yield per plant (g)</th>
<th>Days to 50% flowering@</th>
<th>Plant height upto primary raceme (cm)</th>
<th>No. of nodes upto primary raceme</th>
<th>Length of primary raceme (cm)</th>
<th>Racemes per plant</th>
<th>Capsules per plant</th>
<th>100 seed weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JP 65 X JH 120</td>
<td>126.66 (158.7)</td>
<td>-1.81</td>
<td>-8.82</td>
<td>-19.08</td>
<td>87.28</td>
<td>87.71</td>
<td>81.98</td>
<td>-11.49</td>
</tr>
<tr>
<td>240 X USSR 2</td>
<td>118.93 (162.7)</td>
<td>15.22</td>
<td>-28.39</td>
<td>-7.13*</td>
<td>21.53</td>
<td>31.95</td>
<td>65.07</td>
<td>12.15</td>
</tr>
<tr>
<td>JP 65 X Salam local</td>
<td>98.85 (151.3)</td>
<td>10.78</td>
<td>-4.32</td>
<td>-8.37</td>
<td>41.01</td>
<td>31.98</td>
<td>90.54</td>
<td>0.29ns</td>
</tr>
<tr>
<td>JP 65 X RC 43</td>
<td>97.73 (147.4)</td>
<td>5.38</td>
<td>-20.62</td>
<td>1.12 ns</td>
<td>45.29</td>
<td>54.82</td>
<td>68.35</td>
<td>18.41</td>
</tr>
<tr>
<td>LRES 17 X RC 1226</td>
<td>95.65 (183.2)</td>
<td>8.87</td>
<td>-55.09</td>
<td>-16.04</td>
<td>-3.46 ns</td>
<td>100.49</td>
<td>54.58</td>
<td>10.39</td>
</tr>
<tr>
<td>JP 65 X USSR 2</td>
<td>86.56 (132.7)</td>
<td>18.06</td>
<td>-22.20</td>
<td>3.94 ns</td>
<td>45.64</td>
<td>36.62</td>
<td>68.88</td>
<td>20.66</td>
</tr>
<tr>
<td>240 X JI 1</td>
<td>84.98 (139.9)</td>
<td>3.87 ns</td>
<td>-56.46</td>
<td>-12.85</td>
<td>41.08</td>
<td>-3.19 ns</td>
<td>44.78</td>
<td>17.53</td>
</tr>
<tr>
<td>215 X SH 63</td>
<td>83.13 (152.2)</td>
<td>2.73 ns</td>
<td>-22.73</td>
<td>-7.99</td>
<td>71.80</td>
<td>48.92</td>
<td>63.28</td>
<td>5.42</td>
</tr>
<tr>
<td>JP 65 X 60-16-11</td>
<td>79.15 (125.3)</td>
<td>26.07</td>
<td>-36.97</td>
<td>-4.66 ns</td>
<td>29.45</td>
<td>-4.86</td>
<td>48.98</td>
<td>20.60</td>
</tr>
<tr>
<td>240 X SH 63</td>
<td>77.84 (147.8)</td>
<td>32.24</td>
<td>-8.22</td>
<td>19.32</td>
<td>53.38</td>
<td>80.56</td>
<td>65.31</td>
<td>5.42</td>
</tr>
<tr>
<td>SE</td>
<td>1.92 (12.9)</td>
<td>0.70</td>
<td>2.33</td>
<td>0.50</td>
<td>1.14</td>
<td>0.12</td>
<td>4.63</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Values in parentheses are mean yield per plant in g.
All significant at 1% except NS and *, which are nonsignificant and significant at 5% level, respectively.
@ Negative heterosis is preferable.
was not reflected in the resulting hybrid, whereas
the hybrid resulting from LRES 17 as one of the
parents with other parents (i.e., LRES (7xRC (226))
recorded less yield exhibited substantial increase
in yield with high percentage of heterosis. Such
situation could be attributable to high inter-allelic
interaction canceling the individual effects of each
other.

The investigation reveals that the magnitude
and nature of heterosis for yield and its
components in the crosses were high over
environments in the hybrids. These hybrids may
be utilized for commercial exploitation of heterosis.

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Inheritance of yield and its components in castor.

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SEED HARDENING TO AUGMENT THE PRODUCTIVITY OF COTTON
ev.LRA 5166 (Gossypium hirsutum L.)

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ABSTRACT

Field experiments conducted in summer and winter 1996 seasons to assess the
productivity of hardened seeds highlighted significant benefits of seed hardening with
prosopis (Prosopis juliflora) (0.5% solution) and pungam leaf extract (Pungeres plumulat)
(1.0%) registering increase in field emergence (9%), dry matter production (26.1% on 30
DAS), plant height at harvest (23.2%) over control. The plants from hardened seeds came
to flowering one week earlier than those from nonhardened seeds. The number of sympodia
plant\(^1\), number of boll plant\(^1\), boll weight, seed weight boll\(^1\), number of seeds boll\(^1\) were
significantly higher in plants from seeds given seed hardening treatment with 1.0% pungam
leaf extract striking an increase of 7.9, 35.2, 29.0 and 18.0% respectively over control in
two seasons trials. The seed cotton yield and seed yield were higher by 31.7 and 35.7% respectively in the summer crop and 43.6 and 48.0% respectively in the winter crop in
the same treatment over control. In the resultant seeds better quality vested with the
seeds from botanical hardening.

Cotton is an important fibre crop grown in
India in about 76 lakh hectares, out of which 52
lakh hectares are under rainfed condition. The
national average yield is 268 to 302 kg ha\(^{-1}\) as
against the global average of 595 kg ha\(^{-1}\). The low
productivity in cotton is attributed to several
reasons of which, use of poor quality seed for
sowing forms the major one. Even good quality
seeds may perform poor under adverse ecological
conditions like moisture stress, high temperature.
The present study, was made to explore the
feasibility of using easily available botanicals for
getting desired hardening effect to withstand
drought during the early phase of germination and
seedling growth.