Genetic Variability and Correlation Studies in Some Quantitative Characters in Castor (Ricinus communis L.) Accessions

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Abstract: The study was conducted to determine the variability and association between yield and yield components of Castor accessions. Data such as, (Plant Height, Leaf Area, Node to Primary Panicle, Branches per plant, Panicle per plant, Days to 50% Maturity, Capsule per plant, 100-seed weight and seed yield per plant) were evaluated at two locations (Lafia and Makurdi) using Randomized Complete Block Design. Among the fourteen traits evaluated, there were large GxE interaction for 5 traits observed viz; Capsule/Plant, days to 50% Maturity, 100-seed weight and seed yield/plant implying significant environmental influence in the manifestation of these traits. The result of correlation analysis revealed that Panicle/plant, Capsule/plant, Panicle length and Branches had negative and significant correlation with seed yield. Wide disparity in the estimate of genetic variation was observed for all the traits. Phenotypic variations in many of the traits were largely non-genetic and broad sense heritability estimate were relatively high for most of the traits except branches per plant. Among the treatments, accession 9 gave the best yield (492.1 and 759.7) kg/ha at both locations, followed by accessions 2 and 5 yielding (418.2-452) kg/ha at Makurdi and accession 7 yielding 494.32 kg/ha at Lafia. This suggested that accession 2, 5, 7 and 9 could be used in crosses to isolate high yield lines in breeding.

Keywords: Castor accessions, correlation, genetic variability, quantitative characters, yield

INTRODUCTION

Quantitative assessment of yield is important as a primary step in breeding for improvement. There is a wide variability among the diverse available genotypes for desirable traits (Uguru, 2000). In plant breeding, the type of selection to be done and progress from selection for a particular character depends in part on the magnitude of heritability estimate (Ajibade and Morakinyo, 2000). Ariyo (1995) stated that phenotypic variability and the heritability of character determine to a large extent the rate of genetic advance. The correlations are very important in plant breeding, because of its reflection in dependence degree between two or more traits. If there is genetic correlation between traits in the case of direct selection of one trait, this can cause change in another trait. Correlations between traits are depending on genetic and environmental factors (Falconer, 1989). Environmental conditions can cause variability, not only of some traits but interrelationships between them. Agro ecological conditions can exert influence on change, not only yield and yield components and it can also challenge differences of its reciprocal correlation (Malik et al., 1987). Most times, characters are correlated and knowledge of the relationships among various quantitative and qualitative characters is an essential aid to the choice of appropriate parameters to be used as selection indices.

The aim of this study is to compare the results obtained from genetic variability and phenotypic correlation among different traits associated with yield.

MATERIALS AND METHODS

During 2006 rainy season, nine castor accessions were collected from different locations of north central and southern guinea Savannah agro-ecological zones of Nigeria. These collections included 3 accessions from Benue, 2 each from Enugu and Kaduna, while 1 each from Nasarawa and Plateau States (Table 1).

All accessions were shown in randomized complete block design with three replications. Seven hills (2 seeds/hill) of each accession in three rows were planted on 17th and 18th June 2006 at two locations (Makurdi in Benue and Lafia in Nasarawa States) in rows spaced 0.75 m and the hills were spaced 0.5 m intra row. Upon germination each hill was thinned to one plant/hill.

Data on plant Height (pH), Leaf Area (LA), Nodes to Primary Panicle (NPP), Panicle Length (PL), Number of Panicle/Plant (NPP), Branches/Plant (BPP), Capsule/Plant (CPP), Days to 50% Flowering (D50F), Days to 50% Maturity (D50M), 100-Seed Weight (100SW) Seed Yield per Plant (SYP) were recorded on 5 plants in the middle row of each plot.

All variables measured were subjected to a combined analysis of variance over locations (Steel and Torrie, 1980). Locations were considered random,
The performances of the accessions are as shown in Table 1, while the combined analyses of variance for all traits are presented in Table 2. Table 3 shows the correlation coefficient among the traits. The estimates of genetic parameters are as presented in Table 4. The performance of the crop in the two locations varied (Table 1). Growth characters i.e., plant height leaf area, nodes to first panicle and Number of branches per plant, Panicle length, Capsule per plant, 100-seed weight and seed yield per plant performed better in Lafia. This could be due to variation in environmental condition in the locations as reported by Adeyemo and Fakorede (1986) in their study.

In Table 1, plant height ranged from 103.10-216.30 (cm) with the mean of 245.07+0.471. This implies the existence of short, moderate and long genotypes. Plant height had significant positive correlation value of 0.526** having branches per plant more at the main stem shown by a highly significant correlation value “r” = 0.88* of Nodes to Primary Panicle (NPP) on the main stem (Table 3). They Number of branches per Plant (NPP) ranged from 1.77-4.30 with the mean of 2.45+0.28. This shows that some genotypes had profuse branching habits. Branching is a useful agronomic trait therefore genotype x locations interaction was used to test genotypes. Components of variance were estimated as described by Singh and Chaudhay (1979). Broad sense heritability and genetic coefficient of variability were calculated following Falconer (1989). And expected selection gain was calculated following the methods of Allard (1960) using a selection intensity of 0.88* of Nodes to Primary Panicle (NPP) on the main stem shown by a highly significant correlation value “r” = 0.88* of Nodes to Primary Panicle (NPP) on the main stem (Table 3). They Number of branches per Plant (NPP) ranged from 1.77-4.30 with the mean of 2.45+0.28. This shows that some genotypes had profuse branching habits. Branching is a useful agronomic trait

Table 1: Performance of nine accessions of castor cultivated in Makurdi and Lafia locations during 2006 rainy seasons

<table>
<thead>
<tr>
<th>Accession</th>
<th>pH (cm)</th>
<th>LA (cm)</th>
<th>NBP</th>
<th>NFP</th>
<th>CPF</th>
<th>PLP (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S/N</td>
<td>L1</td>
<td>L2</td>
<td>L1</td>
<td>L2</td>
<td>L1</td>
<td>L2</td>
</tr>
<tr>
<td>1</td>
<td>Kaduna</td>
<td>119.85</td>
<td>114.20</td>
<td>564.40</td>
<td>442.240</td>
<td>1.77</td>
</tr>
<tr>
<td>2</td>
<td>Nasarawa</td>
<td>196.55</td>
<td>138.40</td>
<td>1557.50</td>
<td>1186.50</td>
<td>3.22</td>
</tr>
<tr>
<td>3</td>
<td>Benue</td>
<td>147.68</td>
<td>103.10</td>
<td>561.000</td>
<td>944.800</td>
<td>2.67</td>
</tr>
<tr>
<td>4</td>
<td>Enugu</td>
<td>189.17</td>
<td>137.00</td>
<td>970.600</td>
<td>1305.23</td>
<td>3.33</td>
</tr>
<tr>
<td>5</td>
<td>Benue</td>
<td>176.50</td>
<td>107.30</td>
<td>690.370</td>
<td>829.210</td>
<td>3.67</td>
</tr>
<tr>
<td>6</td>
<td>Enugu</td>
<td>195.67</td>
<td>170.50</td>
<td>1329.20</td>
<td>1258.55</td>
<td>3.67</td>
</tr>
<tr>
<td>7</td>
<td>Benue</td>
<td>171.50</td>
<td>153.80</td>
<td>763.430</td>
<td>1120.41</td>
<td>2.67</td>
</tr>
<tr>
<td>8</td>
<td>plateau</td>
<td>189.83</td>
<td>122.67</td>
<td>1464.80</td>
<td>1244.62</td>
<td>3.53</td>
</tr>
<tr>
<td>9</td>
<td>Kaduna</td>
<td>216.30</td>
<td>141.78</td>
<td>984.700</td>
<td>1267.50</td>
<td>4.30</td>
</tr>
</tbody>
</table>

Mean

PLSD  26.305  256.770  1.034  1.520  3.960  8.1000  1.008  12.234  5.9010  1.12  2.6740

Table 2: Combined Analysis of variance showing source of variance, degree of freedom and means square for agronomic characters in some castor accessions

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>DF</th>
<th>pH</th>
<th>LA</th>
<th>NBP</th>
<th>NFP</th>
<th>CPF</th>
<th>PLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block</td>
<td>2</td>
<td>994.690</td>
<td>25665.75</td>
<td>0.796</td>
<td>5.570</td>
<td>121.72</td>
<td>97.0190</td>
</tr>
<tr>
<td>Location</td>
<td>1</td>
<td>30845.34*</td>
<td>72481.25*</td>
<td>3.130*</td>
<td>9.380*</td>
<td>778.24*</td>
<td>554.241*</td>
</tr>
<tr>
<td>Location X</td>
<td>8</td>
<td>2712.820**</td>
<td>551129.0**</td>
<td>2.935**</td>
<td>21.69**</td>
<td>131.92**</td>
<td>873.588**</td>
</tr>
<tr>
<td>Genotype</td>
<td>4</td>
<td>763.15*</td>
<td>102277.11*</td>
<td>0.546*</td>
<td>36.49*</td>
<td>36.49*</td>
<td>152.199**</td>
</tr>
<tr>
<td>Error</td>
<td>34</td>
<td>502.64</td>
<td>74893.22</td>
<td>0.776</td>
<td>1.670</td>
<td>11.36</td>
<td>47.6070</td>
</tr>
<tr>
<td>F-Value (0.05)</td>
<td>26.305</td>
<td>256.770</td>
<td>1.034</td>
<td>1.520</td>
<td>3.960</td>
<td>8.1000</td>
<td>1.008</td>
</tr>
</tbody>
</table>

* **: Significant at 5% and 1% of probability, respectively

RESULTS AND DISCUSSION

The performances of the accessions are as shown in Table 1, while the combined analyses of variance for all traits are presented in Table 2. Table 3 shows the correlation coefficient among the traits. The estimates of genetic parameters are as presented in Table 4. The performance of the crop in the two locations varied (Table 1). Growth characters i.e., plant height leaf area, nodes to first panicle and Number of branches per plant, Panicle length, Capsule per plant, 100-seed weight and seed yield per plant performed better in Lafia. This could be due to variation in environmental condition in the locations as reported by Adeyemo and Fakorede (1986) in their study.

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had the best yield at both locations while accession 5
between (127-148 days) at both locations. Accession 9
flowered within (79-93 days) and pods matured late
between (116-146 days). The remaining accessions
flowered within 66-92 days and pods matured early
respectively depending on varieties. Accessions 5 and 9
maturity of castor was between 2-6 and 3-5 months
Manga (2007) revealed that the period of flowering to
Previous report by Benzatto and Roche (1965) and
Bello (2010). On days to flowering and maturity, the
This result is similar to the study of Abimiku and
Bello (2010). On days to flowering and maturity, the
genotypes were statistically separated into two groups.
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result is similar to the study of Abimiku and Bello (2010).
However, their period of flowering to maturity
was longer than that of Lafia. This could be because
there was significant interaction of Genotype x
Location (GxL) in five traits i.e., Days to 50% Fl1owering,
Days to 50% Maturity, Capsule per plant, 100 seed weight,
and seed yield per plant at both locations. This could be
because a wide spread abortion of primary flowers
was observed in Makurdi Location which were higher
than those of Lafia even though Makurdi Location flower earlier compared
with Lafia. The flower abortion effect could be
attributed to the Cloudy high relative humidity and high
rainfall during the primary flower production which
caused poor performance of the entries in capsule/ plant,
100 Seed weight and seed yield at Makurdi locations.
This result is similar to the study of Manga (2007) on
castor plant.

The components of variation, coefficient of
variation and heritability estimates of the characters are
as the pod bearing inflorescence terminate each branch
this is as shown it highly correlates with panicle per
plant and seed yield per plant (r = 0.548**) and
0.428**) respectively (Table 3).

Table 3: Correlation coefficient among the traits of castor studied in Makurdi and Lafia

<table>
<thead>
<tr>
<th>Character</th>
<th>Plant height (cm)</th>
<th>Leaf area (cm²)</th>
<th>Panicle length/plant</th>
<th>BPP</th>
<th>D50F1</th>
<th>D50M</th>
<th>PS</th>
<th>100Sw (g)</th>
<th>SYP</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>0.28*</td>
<td>-0.171</td>
<td>0.167</td>
<td>0.310*</td>
<td>0.477**</td>
<td>-0.042</td>
<td>0.041</td>
<td>0.051</td>
<td>0.051</td>
</tr>
<tr>
<td>LA</td>
<td>0.489**</td>
<td>-0.226</td>
<td>0.232**</td>
<td>-0.299*</td>
<td>0.477**</td>
<td>0.249</td>
<td>0.394**</td>
<td>0.393**</td>
<td>0.393**</td>
</tr>
<tr>
<td>LLN</td>
<td>0.760</td>
<td>0.324**</td>
<td>-0.058</td>
<td>0.030*</td>
<td>0.519**</td>
<td>0.402**</td>
<td>0.691**</td>
<td>0.402**</td>
<td>0.402**</td>
</tr>
<tr>
<td>PP</td>
<td>0.104</td>
<td>-0.106</td>
<td>0.282**</td>
<td>-0.548**</td>
<td>0.580**</td>
<td>0.159</td>
<td>0.619**</td>
<td>0.580**</td>
<td>0.580**</td>
</tr>
<tr>
<td>NPP</td>
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<td>PLP</td>
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<td></td>
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<tr>
<td>CPP</td>
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<td></td>
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<tr>
<td>D50F1</td>
<td></td>
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<td>D50M</td>
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<td>SYP</td>
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<td></td>
</tr>
</tbody>
</table>

Table 4: Components of variance Coefficients of Variability (CV) heritability in broad sense and genetic advances of agronomic traits of some castor accessions

<table>
<thead>
<tr>
<th>Character</th>
<th>Genotypic variance</th>
<th>Phenotypic variance</th>
<th>Environmental variance</th>
<th>Genotypic coeff. of variation</th>
<th>Phenotypic coeff. of variation</th>
<th>Broad sense heritability (ph2t)</th>
<th>Genetic advance as % means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height (cm)</td>
<td>736.73</td>
<td>1239.37</td>
<td>562.64</td>
<td>17.80</td>
<td>23.08</td>
<td>0.59</td>
<td>29.27</td>
</tr>
<tr>
<td>Leaf area (cm²)</td>
<td>0.045</td>
<td>0.031</td>
<td>0.460</td>
<td>44.66</td>
<td>0.78</td>
<td>71.88</td>
<td></td>
</tr>
<tr>
<td>Node 1 panicle (No.)</td>
<td>6.670</td>
<td>1.670</td>
<td>1.37</td>
<td>14.95</td>
<td>0.80</td>
<td>24.63</td>
<td></td>
</tr>
<tr>
<td>Branches/panicle (No.)</td>
<td>0.7200</td>
<td>0.780</td>
<td>28.45</td>
<td>41.95</td>
<td>0.48</td>
<td>40.64</td>
<td></td>
</tr>
<tr>
<td>Panicle/plant (No.)</td>
<td>1.1000</td>
<td>0.740</td>
<td>31.09</td>
<td>40.20</td>
<td>0.60</td>
<td>49.55</td>
<td></td>
</tr>
<tr>
<td>Panicle length/plant</td>
<td>75.860</td>
<td>22.29</td>
<td>41.15</td>
<td>47.52</td>
<td>0.75</td>
<td>40.64</td>
<td></td>
</tr>
<tr>
<td>Days to 50% flowering</td>
<td>40.180</td>
<td>51.550</td>
<td>7.870</td>
<td>8.920</td>
<td>0.78</td>
<td>14.32</td>
<td></td>
</tr>
<tr>
<td>Days to 50% maturity</td>
<td>275.33</td>
<td>47.61</td>
<td>11.99</td>
<td>12.98</td>
<td>0.85</td>
<td>22.80</td>
<td></td>
</tr>
<tr>
<td>Capsule/plant (No.)</td>
<td>529.29</td>
<td>108.72</td>
<td>73.08</td>
<td>80.23</td>
<td>0.83</td>
<td>137.12</td>
<td></td>
</tr>
<tr>
<td>Seed weight (100 g)</td>
<td>129.53</td>
<td>78.25</td>
<td>78.53</td>
<td>80.23</td>
<td>0.83</td>
<td>160.63</td>
<td></td>
</tr>
<tr>
<td>Seed yield/plant (g)</td>
<td>53.790</td>
<td>82.59</td>
<td>86.48</td>
<td>86.48</td>
<td>0.91</td>
<td>162.47</td>
<td></td>
</tr>
<tr>
<td>Seed yield/hectare (kg)</td>
<td>31319.73</td>
<td>77515.24</td>
<td>58.78</td>
<td>109.58</td>
<td>0.92</td>
<td>164.96</td>
<td></td>
</tr>
</tbody>
</table>

** Correlation is significant at 0.01 levels; *: Correlation is significant at 0.05 levels

This result is similar to the study of Abimiku and
Bello (2010). On days to flowering and maturity, the
genotypes were statistically separated into two groups.
Previous report by Benzatto and Roche (1965) and
Manga (2007) revealed that the period of flowering
to maturity of castor was between 2-6 and 3-5 months
respectively depending on varieties. Accessions 5 and 9
flowered within 66-92 days and pods matured early
between (116-146 days). The remaining accessions
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between (127-148 days) at both locations. Accession 9
had the best yield at both locations while accession 5
performed best at Makurdi than Lafia (Table 1). This
result is similar to the study of Abimiku and Bello (2010).
However, their period of flowering to maturity
showed that they are early maturing accessions, thus
selection could be necessary for these accessions. Days
to 50% flowering had highly positive correlation
(r = 0.496**) to days to 50% maturity, while days to
50% maturity showed highly correlation (r = 0.393**) with 100-seed weight but had negative correlation
(0.556**) with seed yield per plant (Table 3). This
implies that accessions which mature early had lower
seed weight but yield more. While accessions that
mature late had higher seed weight but yield less. This
agreed with the findings of Weiss (1971), who revealed
that climatic factors e.g., rainfall, temperature, relative
humidity affect seed yield.

The combined analysis for the castor accession
evaluated at both locations revealed differences among
the treatment for all the character as presented in
(Table 2). The significant variability exhibited showed
that the accessions are diverse (Harbans et al., 1997;
Uguru, 2000; Manga, 2007) in their study on castor
reported that such variations are useful in plant
breeding as they provide heterogeneous population for
a wide spectrum of genotypes for selection programme
if genetic information on how these characters are
inherited is known.

There was significant interaction of Genotype x
Location (GxL) in five traits i.e., Days to 50% Fl1owering,
Days to 50% Maturity, Capsule per plant, 100 seed weight,
and seed yield per hectare at both locations. This could be
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100 Seed weight and seed yield at Makurdi locations.
This result is similar to the study of Manga (2007) on
castor plant.

The components of variation, coefficient of
variation and heritability estimates of the characters are
presented in Table 4. Large phenotypic variation and phenotypic coefficient variation estimates in the two locations were observed in 9 characters viz: plant height, leaf area, panicle length per plant, Days to 50% flowering, Days to 50% maturity, capsule per plant, 100 seed weight, seed yield per plant and seed yield/hectare.

This report is similar the study of Abimiku and Bellow (2010) who revealed that when environmental variance estimate for a trait appears to be higher than its genotypic variance estimate, the variation of that trait would largely depend on environmental influence rather than genetic effect. Since these characters were largely phenotypically influenced than genotypic effective, selection for these traits could be allowed for improvement on the crop.

A large significant genotype x location interaction was found in all the traits (Table 2). The interaction mean square for all the traits resulted to be lower than genotypic mean square; therefore, genotypic variance was not zero. Adeyemo and Fakorede (1986), Laurentin and Montilla (2002) pointed out that a breeder could utilize several combination in different environment in a selection program.

Majumder et al. (1969) and Abimiku and Belo (2010) revealed that genotypic coefficient of variation helps to measure the range of variability in a character and provides a measure to compare variabilities present in a population. The coefficient of variation in 4 traits viz: leaf area, branches/plant, number of panicles/plant and panicle length/plant were moderate and it was high in number of capsules, 100-seed weight seed yield/plant and seed yield/hectare. This suggests that selection from population with such moderate and high coefficient of variation values in the yield traits could be effective in improvement of these traits.

The estimate of broad sense heritability ranged from 48-92% for seed yield (Table 4). The number of capsule per plant, 100 seed weight, seed yield/plant and seed yield/hectare had high genetic component as shown by GCV of 73.08, 78.25, 82.59 and 58.78, respectively, while seed yield/hectare had the highest heritability value of 92.0%. These characters also had high values of Genetic Advance (GA). Their high positive significant correlation values (r = 0.650**, 0.350* and 0.470*) (Table 3) with seed yield indicate that these parameters are useful agronomic tools for the improvement of seed yield in castor. Kaul and Bham (1974) revealed that when high or moderate genetic advance is predicted, for a particular trait, its broad sense heritability estimate may be considered and accepted as a reliable and useful instrument in the prediction of genetic response to selection. The moderate heritability and low genetic advance as observed in some characters suggest that the variability in these traits were mainly due to non-additive gene action and hence a limitation for selection in respect of these traits. However, this investigation showed that improvement of seed yield via direct selection is possible for high number of panicle per plant, panicle length and capsule per plant and branches per plant.

REFERENCES


