ESTIMATES OF GENETIC COMPONENTS IN DIALLEL CROSSES 
FOR YIELD AND YIELD CONTRIBUTING CHARACTERS 
IN RICE (ORYZA SATIVA L.)

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Abstract: An experiment was carried out to study the genetic components for seven yield and yield components in rice using a 7-parent diallel cross excluding reciprocals during kharif 2009. The parental genotypes used in the study were BPT 5204, MTU 1010, JGL 3844, NLR 34449, MTU 1081, MTU 1075 and JGL 13595. Hayman’s analysis of variance (ANOVA) indicated that the traits plant height at maturity, number of tillers per plant, grain yield per plant, were although influenced by both additive and non additive genetic components, the non additive gene actions was more important in controlling the inheritance of these traits. Only dominance genetic component was significant for number of panicles per plant while only additive component was important for panicle length, 1000 grain weight. In case of days to 50% flowering both additive and non additive gene actions were important but additive component was more predominant. Major role of recessive genes was observed in the expression of the traits days to 50% flowering, panicle length. The value of degree of dominance was more than one for all the traits except days to 50% flowering, panicle length and 1000 grain weight indicating the significance of over dominance. Progeny selection was suggested for improvement of 1000-grain weight and panicle length and for other traits only population improvement methods are ideal.

Keywords: Rice, genetic components, diallel, Hayman’s approach, yield and yield components, additive and anon additive.

Introduction

Information about the inheritance of controlling the metric traits are worth prime for planning and executing a breeding strategy leading to their genetic improvement. Gene action in rice has been determined mostly by using diallel method which furnishes information on additive and dominant gene effects. Detailed information concerning the genetic control of the characters under selection is important if plant breeders are to conduct their programme efficiently by the choice of appropriate parents and selection methodology. With this background a breeding effort was initiated at APRRI & RARS, Maruteru during 2008 and 2009.

Materials and methods

Seven parents viz., BPT 5204, MTU 1010, JGL 3844, NLR 34449, MTU 1081, MTU 1075 and JGL 13595 were selected based on genetic distance, cluster means and per se
performance for use in hybridization. The parents were sown at staggered intervals of 10
days, during Rabi 2008-09 to facilitate continuous availability of pollen during crossing.  
Hybridization was done by employing clipping method and emasculation was carried out in 
afternoon and pollination in morning of next day. Parents were crossed in a diallel fashion 
without reciprocals and generated seed of 21 crosses. All twenty-one F₁s and their parents 
were grown in a randomized complete block design with three replications at APRRI & 
RARS, Maruteru during Kharif 2009. All the recommended package of practices was 
followed to raise the crop. Observation were recorded on days to 50% flowering, plant height 
(cm), number of tillers per plant, number of panicles per plant, panicle length (cm), 1000 
grain weight (g) and grain yield (g) per plant in each replication. Data was analyzed using the 
Hayman’s approach (1954a and 1954b) as per Singh and Chaudhary (1995). From the data 
analysis we obtained: (i) variations due to additive effect (D); (ii) the mean of 'Fr' over the 
arrays (F), Fr is the covariance of additives and non-additive effects in single array; (iii) 
components of variation due to the dominance effect of the genes (H1); (iv) calculations to 
predict the proportion of positive and negative genes in the parents (H2); (v) the dominance 
effects (as the algebraic sum over all loci in heterozygous phase in all crosses) (h2); (vi) the 
expected environmental components of variation (E); (vii) the mean degree of dominance 
((H1/D)1/2); (viii) the proportion of genes with positive and negative effects in the parents 
(H2/4H1) and (ix) the proportion of dominant and recessive genes in the parents (Kd/Kr); (x) 
the number of groups of genes which control the character and exhibit dominance (h2/H2).

Results

1. Days to 50 per cent flowering: Both additive (D) and non-additive components (H₁ and 
H₂) were found significant, indicating the importance of both additive and non-additive gene 
actions in controlling the expression of this trait. Major role of recessive genes in the 
expression of this trait was confirmed by a negative estimate of `F’ and a less than one ratio 
of KD/Kr. The ratio of H₂/4H₁ was less than 0.25 suggesting unequal distribution of positive 
and negative genes (Table1).

2. Plant height at maturity: Significance of additive (D) and dominance (H₁ and H₂) 
components were noticed for this character indicating role of additive and non additive gene 
action. The estimate of `F’ was positive and significant. Mean degree of dominance was 
more than one suggesting over dominance for this character (Table 1). The H₂/4H₁ ratio was 
less than 0.25 indicating unequal distribution of genes with positive and negative effects.
KD/Kr ratio was more than one, indicating presence of more dominant genes in controlling the character.

**3. Number of tillers per plant:** Both additive (D) and non-additive components (H₁ and H₂) were found significant, indicating the importance of both additive and non-additive gene actions in controlling the expression of this trait. The estimate of `F' was not significant but positive. KD/Kr ratio was more than unity suggesting influence of high proportion of dominant genes. The value of degree of dominance was more than one indicating the significance of over dominance. H₂/4H₁ ratio was less than 0.25 confirming asymmetrical distribution of genes with positive and negative effects (Table 1).

**4. Number of panicles per plant:** Only dominance genetic component was found to be significant for this trait. `F' estimate was positive and not significant. KD/Kr ratio was much higher than unity thus indicating presence of dominant genes. Estimate of mean degree of dominance was more than one suggesting over dominance (Table 1). The genes with positive and negative effects were unequally distributed since the H₂/4H₁ ratio was less than 0.25.

**5. Panicle length:** Only additive component (D) was found significant for this character (Table 1). The estimate of `F' was negative and non-significant. KD/Kr ratio was less than one showing major influence of recessive genes in the expression of the trait. Mean degree of dominance was lower than unity suggesting partial dominance. H₂/4H₁ recorded a ratio higher than 0.25 indicating equal distribution of genes with positive and negative effects among the parents. h²/H₂ ratio was more than one, which revealed that at least 1 to 2 gene groups among the genes controlling the character expressed additive effect.

**6. 1000 grain weight:** The additive component (D) was found significant for 1000 grain weight (Table 1). The estimate of `F' was negative and non-significant. KD/Kr ratio was less than one showing major influence of recessive genes in the expression of the trait. Mean degree of dominance was lower than unity suggesting partial dominance. H₂/4H₁ recorded a ratio was less than 0.25 confirming asymmetrical distribution of genes with positive and negative effects.

**7. Grain yield per plant:** Both D and H₁ and H₂ were found significant. Relative magnitude of dominance component was greater than additive component. The estimate of `F' which indicates distribution of dominant and recessive genes was found to be non significant and positive (Table 1). KD/Kr ratio of more than unity also supported that dominant genes were responsible in the expression of this character. Estimate of degree of dominance was more
than one suggesting the presence of over-dominance. The ratio of $H_2/4H_1$ was 0.231 indicating equal distribution of genes.

**Discussion**

Genetic component analysis revealed that the traits plant height at maturity, number of tillers per plant, grain yield per plant, were although influenced by both additive and non additive genetic components, the non additive gene actions was more important in controlling the inheritance of these traits. Only dominance genetic component was significant for number of panicles per plant while only additive component was important for panicle length, 1000 grain weight. In case of days to 50% flowering both additive and non additive gene actions were important but additive component was more predominant. Akram *et al.* (2007) observed predominant additive gene action for tillers per plant, predominant of dominant gene action for panicle length, 1000 grain weight and only non additive gene action for grain yield per plant. Kaushik (1984) and Lakshmi (2009) reported the importance of non additive gene effects in the inheritance of the panicle length and 1000 seed weight which was in contradictory to the present results. Haque *et al.* (1981) reported major role of additive gene effects in controlling the inheritance of 1000 seed weight which was similar to the present result. As per Raju *et al.* (2012) all the components of yield and yield except 1000 grain weight were under the influence of non-additive gene action.

Major role of recessive genes was observed in the expression of the traits days to 50% flowering, panicle length which was confirmed by a negative estimate of 'F' and a less than one ratio of KD/Kr. The ratio of $H_2/4H_1$ was less than 0.25 for the all the characters except for panicle length suggesting unequal distribution of positive and negative genes.

The value of degree of dominance was more than one for all the traits except days to 50% flowering, panicle length and 1000 grain weight indicating the significance of over dominance. Akram *et al.* (2007) reported partial dominance for tillers per plant panicle length and grain yield per plant and over dominance for 100 seed weight which opposed the present results.

**Conclusion**

From the foregoing it may be inferred and concluded that the characters (panicle length, 1000 grain weight) exhibited additive component may be used for direct phenotypic selection in segregating populations. For the characters exhibiting both additive and non additive type of gene action and over dominance the material can be exploited for heterotic effects and population improvement methods are ideal.
References


Table 1: Estimates of genetic components and other parameters for yield and yield contributing characters in F₁ crosses

<table>
<thead>
<tr>
<th>Component</th>
<th>Days to 50% flowering</th>
<th>Plant height at maturity (cm)</th>
<th>Number of tillers per plant</th>
<th>Number of panicles per plant</th>
<th>Panicle length (cm)</th>
<th>1000 grain weight (g)</th>
<th>Grain yield/plant (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>98.72** ± 5.42</td>
<td>92.52**±13.20</td>
<td>14.18* ±±5.23</td>
<td>6.664±3.683</td>
<td>2.196*±0.258</td>
<td>11.31*±1.693</td>
<td>6.73*±3.16</td>
</tr>
<tr>
<td>F</td>
<td>-46.97±12.99</td>
<td>111.81**±31.37</td>
<td>8.91±12.56</td>
<td>2.867±8.835</td>
<td>-2.49±0.619</td>
<td>-2.96±4.061</td>
<td>1.40±7.59</td>
</tr>
<tr>
<td>H₁</td>
<td>58.63**±13.05</td>
<td>144.64±31.78</td>
<td>38.13**±12.60</td>
<td>26.910*±8.866</td>
<td>0.335±0.621</td>
<td>6.636±4.076</td>
<td>78.03*±7.62</td>
</tr>
<tr>
<td>H₂</td>
<td>41.95**±11.49</td>
<td>93.84**±28.00</td>
<td>32.31**±11.10</td>
<td>23.394*±7.812</td>
<td>0.459±0.547</td>
<td>6.048±3.592</td>
<td>72.09*±6.72</td>
</tr>
<tr>
<td>h²</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.96±7.72</td>
<td>26.49±18.8</td>
<td>19.66**±7.46</td>
<td>16.256*±5.247</td>
<td>1.429*±0.367</td>
<td>-0.421±2.412</td>
<td>328.25*±4.51</td>
</tr>
<tr>
<td>E</td>
<td>2.12±1.91</td>
<td>1.45±4.66</td>
<td>1.81±1.85</td>
<td>1.591±1.302</td>
<td>1.206*±0.091</td>
<td>1.444*±0.598</td>
<td>1.797±1.12</td>
</tr>
<tr>
<td>Degree of dominance</td>
<td>0.771</td>
<td>1.25</td>
<td>1.64</td>
<td>2.009</td>
<td>0.391</td>
<td>0.766</td>
<td>3.405</td>
</tr>
<tr>
<td>H₂/H₁</td>
<td>0.179</td>
<td>0.162</td>
<td>0.212</td>
<td>0.217</td>
<td>0.342</td>
<td>0.228</td>
<td>0.231</td>
</tr>
<tr>
<td>KD/Kr</td>
<td>0.528</td>
<td>2.87</td>
<td>1.474</td>
<td>1.240</td>
<td>-0.184</td>
<td>0.708</td>
<td>1.063</td>
</tr>
<tr>
<td>h²/H₂</td>
<td>0.023</td>
<td>0.282</td>
<td>0.608</td>
<td>0.695</td>
<td>3.113</td>
<td>-0.07</td>
<td>5.637</td>
</tr>
</tbody>
</table>

* Significant at 5% level  ** Significant at 1% level