HERITABILITY ESTIMATES AND YIELD PERFORMANCE OF HALF SIB FAMILIES DERIVED FROM MAIZE VARIETY SARHAD WHITE

KALEEM ULLAH1, HIDAYAT UR RAHMAN1, MUHAMMAD NOOR1, MONSIF UR REHMAN1, MUHAMMAD IQBAL2 and SANAULLAH1

1 Department of Plant Breeding and Genetics, The University of Agriculture, Peshawar – Pakistan
2 Cereal Crop Research Institute, Pirsabak, Nowshera – Pakistan

ABSTRACT

This experiment was conducted to evaluate the performance of 196 half sib families (HSF) derived from Sarhad White variety of maize at the Research Farm of Agricultural University, Peshawar using partially balanced lattice square design with two replications. Results indicated significant differences among HSF for all the studied traits, except grain yield. Among the 196 families, maximum days to tasseleing (58), silking (59) and anthesis (59) were recorded for HSF-58 and HSF-21, respectively. Maximum plant height (197 cm) was observed for HSF-11 while minimum (104 cm) was recorded for HSF- 105 and 145. Minimum ear height (44 cm) was observed for HSF-61 while maximum (102.5 cm) was recorded for HSF-27. Highest kernel rows ear-1 (19) was observed for HSF-152 whereas, minimum (11) was recorded for HSF-134 and HSF-182. Maximum 100 grains weight (42.96 g) was expressed by HSF-23 while minimum (23.05 g) was exhibited by HSF-132. Highest grain yield (11018.5 kg ha-1) was recorded for HSF-117 while minimum grain yield (987.5 kg ha-1) was recorded for HSF-67. Maximum heritability estimate (69.17 %) was observed for plant height, while minimum (5.08 %) was observed for days to mid-silking. Highest correlation of yield was recorded with ear height. These results suggest that these half-sib families could be used as source of improved maize germplasm for developing maize genotypes with superior attributes.

Key Words:  Half Sib Families, Recurrent Selection, Phenotypic Correlation, Broad Sense Heritability, Maize

INTRODUCTION

Maize (Zea mays L.) is one of the world’s leading cereal crops. It belongs to family Poaceae, having diploid chromosome as 20. It is a short day plant with monocious nature of flowering. It does not survive in wild form probably because of its highly cross pollinated nature. It is a short duration crop and is grown twice a year i.e. spring and summer (Allard, 1996). Maize is the third most important cereal crop in Pakistan following wheat and rice. It is a multipurpose crop, used for food, feed as well as fodder. It is also used in industries for making starch, alcohol, tanning material, oil and polishes etc (Fehr, 1987).

During 2008-09 it was planted on 1052 thousand hectares in Pakistan with a total production of 3593 thousand tons, having an average yield of 3415 kg per hectare (MINFAL, 2008-09). In Khyber Pakhtunkhwa it is a primary crop in majority of the cropping systems and staple food of the rural population in most of the province. A considerable area of approximately 500,000 ha in plains and high mountains is planted with maize (Rahman, 2010). Per hectare production is low in these areas compared with countries of similar climates. Lack of suitable maize varieties with superior attributes is one of these limiting factors.

Maize is the crop with highest per day productivity with a high yield potential. Development of improved varieties with high yield potential can be seen as a possibility to increase production per unit area. Such kind of varieties with improved qualitative and quantitative traits represents one of the most successful aspects of the modern agricultural technology (FAO, 2004). For developing high yielding varieties to increase yield per unit area several methods of selection have been used by maize breeders particularly mass-selection, modified mass-selection, ear-to-row selection and several methods of recurrent selection including selfed-progenies derived from a base populations. Recurrent selection is said to be the most effective method of improvement in maize crop. Recurrent selection is aimed at increasing the frequency of the favorable alleles in a breeding population and hence improves the performance of the population for one or more traits of interest (Horner, 1996).

Half-sib family selection, a type of recurrent selection, refers to the individuals having only one parent in common. Recurrent half-sib selection is a method of intra population improvement that involves the evaluation of the individuals through the half-sib progeny (Wright, 1998). The objectives of this study were to evaluate half-sib families derived from maize variety Sarhad-White to identify superior families that can be used in future maize breeding programs for developing maize genotypes with desirable attributes.
MATERIALS AND METHODS

This experiment was carried out at Malakandher Research Farm, The University of Agriculture, Peshawar, Pakistan during the summer crop season (June-Oct) 2010. Experimental material consisted 196 entries of half-sib families of maize variety ‘Sarhad White’ developed in the spring season at Cereal Crops Research Institute (CCRI) Pirsabak, Nowshera, Pakistan. Sarhad White is a composite of [Vikram (B11 x B37)] x Akbar. It is a white, semi dense variety having medium tall stature, semi dense tassel with profuse branching. During evaluation of half-sib family recurrent in summer season of previous year twenty elite HSF were selected. In recombination phase each selected HSF was sown in separate row and was pollinated using bulk male of the selected HSF. These 196 half-sib families were tested in 14 x 14 partial balanced lattice design with two replications. Plant to plant distance was kept as 25 cm and row-to-row distance was 25 cm with a row length of 4m. Fertilizer was applied at the rate of 120-50 NP kg ha⁻¹. Other cultural practices were carried out at standard level as and when needed.

Data on morphological and yield parameters were recorded during the course of the experiment at specific time. When 50% of the plants in the row showed tassels, silks and pollen shedding, data were recorded as the number of days needed for tasseling, silking and pollen shedding, respectively. The Anthesis silking interval was calculated as the difference between days to silking and days to pollen shedding. Data on plant height and ear height were recorded on five randomly selected plants as the distance from the ground level to the flag leaf node and the upper cob bearing node, respectively. Grain moisture content was recorded using grain-moisture tester after shelling the middle rows of three randomly selected ears at the time of harvest.

All the data were subjected to ANOVA appropriate for 14x14 lattice square design, using computer program “MSTATC”. Means of all characters were compared among the half-sib families. Variance, phenotypic correlations and broad sense heritability estimates were calculated following Fehr (1987).

RESULTS AND DISCUSSION

Flowering Traits

Highly significant differences (P≤0.01) were observed among families for days to mid tasseling while days to mid anthesis and days to mid silking revealed significant (P≤0.05) and non significant differences, respectively. Low co-efficient of variation were observed for mid silking (1.97), mid anthesis (2.37) and mid tasseling (2.4) (Table I). Anthesis silking interval calculated from the difference of days to mid anthesis and days to mid silking showed significant differences. These results are in agreement with those of Hidayatullah et al. (2007) who also reported significant differences for flowering traits while working on the performance of local and exotic inbred-lines of maize under agro-ecological conditions of Peshawar. HSF-35 took maximum (58 days) for mid tasseling while HSF-22 was recorded to have minimum value (51 days) for this trait. HSF-21 was recorded to have Maximum (59 days) for mid silking and mid anthesis while minimum (53 days) were recorded for HSF-22, HSF-35 and HSF-98 (Table II). Heritability estimates for mid-tasseling, mid-silking and mid-anthesis were recorded as 34, 5.08 and 22.61%, respectively (Table I). This is indicative of high environmental influence upon flowering traits in this breeding population. Days to mid-tasseling showed positive correlation with mid-silking, mid-anthesis, plant height and grain yield. Mid-silking showed negative correlation with anthesis silking interval, ear height and grain yield. Elweanya et al. (2005) also reported negative correlation between mid-silking and grain yield.

Plant breeder is interested in pollen silk synchronization and therefore low Anthesis Silking Interval is preferred because extended gap between pollination and silking could lead to low kernel setting and hence reduced grain yield (Noor et al., 2010). Maximum Anthesis Silking Interval (3.5 days) was recorded for HSF-98 while minimum (0 days) was observed for HSF-43, HSF-15, HSF-28 and HSF-149 (Table II). Low heritability estimate of 26.85% was observed for Anthesis Silking Interval.

Plant Height

Plant breeders give special attention to plant height as it can significantly affect grain yield due to lodging in case of taller plants. Analysis regarding plant height revealed highly significant differences (P≤0.01) among 196 half-sib families. Low co-efficient of variation (9.99) was observed with heritability estimate of 69.17% (Table 1). Average plant height ranged from 104cm for HSF-105 to 197cm for HSF-145 with a grand mean of 157.30cm (Table 2). These results are in agreement with those of Noor et al. (2010) who also observed similar results while evaluating maize half-sib families. Plant height showed positive correlation with all other traits except grain moisture at harvest (Table 3).
Grain moisture was observed to be positively correlated with all other traits except days to mid-anthesis and plant height is a major yield contributing trait and is an important parameter for selection (Dash, 1992). Recurrent selection in Krug yellow dent maize population. Ear height was reported to be positively correlated with grain moisture content and grain yield (Table 3). Tanner and Smith (1987) while working on comparison of S1-recurrent selection in Krug yellow dent maize population recorded significant differences for lodging. ANOVA revealed highly significant differences (P≤0.01) for grain moisture at harvest. (Table 1)

Table 1. Mean square values, coefficient of variation and broad sense heritability (h²BS) estimates for flowering, plant, ear and yield traits of half-sib families

<table>
<thead>
<tr>
<th>Traits</th>
<th>Replication (1)</th>
<th>Treatment (195)</th>
<th>Block (26)</th>
<th>Error (169)</th>
<th>CV (%)</th>
<th>h²BS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to Tasseling</td>
<td>0.83</td>
<td>2.714**</td>
<td>4.11</td>
<td>1.79</td>
<td>2.40</td>
<td>34.00</td>
</tr>
<tr>
<td>Days to Silking</td>
<td>3.90</td>
<td>1.32*</td>
<td>1.20</td>
<td>1.25</td>
<td>1.94</td>
<td>5.08</td>
</tr>
<tr>
<td>Days to Anthesis</td>
<td>0.12</td>
<td>2.318*</td>
<td>1.96</td>
<td>1.79</td>
<td>2.37</td>
<td>22.61</td>
</tr>
<tr>
<td>Plant height (cm)</td>
<td>52095.31</td>
<td>801.360**</td>
<td>6728.53</td>
<td>247.07</td>
<td>9.99</td>
<td>69.17</td>
</tr>
<tr>
<td>Ear height (cm)</td>
<td>191.52</td>
<td>121.681**</td>
<td>480.15</td>
<td>64.41</td>
<td>11.38</td>
<td>47.06</td>
</tr>
<tr>
<td>Moisture content (%)</td>
<td>0.298</td>
<td>31.150**</td>
<td>13.77</td>
<td>13.77</td>
<td>10.18</td>
<td>55.81</td>
</tr>
<tr>
<td>100 kernels Weight</td>
<td>2451.20</td>
<td>38.783**</td>
<td>20.12</td>
<td>18.36</td>
<td>12.68</td>
<td>52.66</td>
</tr>
<tr>
<td>Grain yield (kg ha⁻¹)</td>
<td>12972234.0</td>
<td>2159890.33**</td>
<td>865260.33</td>
<td>1357412.8</td>
<td>41.70</td>
<td>37.15</td>
</tr>
</tbody>
</table>

ns = Non significant
* = Significant at 5% level of significance, respectively
** = Significant at 1% level of significance, respectively

Ear Height

Plants having an optimum height and central or near central placement of cobs are more resistant to lodging and hence play a vital role in improving grain yield. Highly significant differences (P≤0.01) were observed for ear height among the half-sib families. Maximum ear height (102.5 cm) was recorded for HSF-27 while minimum (44 cm) was observed for HSF-61 (Table 2). Low co-efficient of variation (11.38) was recorded with heritability estimate of 47.06%. This proves significant environmental affect on this trait. These results are supported by Stromburg and Campton (1989) who also reported significant differences for ear height after 10 cycles of full-sib recurrent selection in an open pollinated maize population. Ear height was reported to be positively correlated with grain moisture content and grain yield (Table 3).

Grain Moisture at Harvest

Grain moisture at harvest is one of the most important characters in maize breeding programs as it helps in determining early and late maturing genotypes. ANOVA revealed highly significant differences (P≤0.01) for grain moisture at harvest among half-sib families. Co-efficient of variation was recorded as 10.18 which is considered as low. Moderate heritability estimate (55.81%) was observed for grain moisture (Table 1). Grain moisture was observed to be positively correlated with all other traits except days to mid-tasseling, mid-anthesis and plant height (Table 3). Tanner and Smith 1987 while working on comparison of S1-recurrent selection in Krug yellow dent maize population recorded significant differences for grain moisture at harvest.

Table 2. Grand means, maximum and minimum values for flowering, plant, ear height and yield traits of half-sib families

<table>
<thead>
<tr>
<th>Traits</th>
<th>Maximum value</th>
<th>Minimum value</th>
<th>Grand mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to Tasseling</td>
<td>58</td>
<td>51</td>
<td>54.45</td>
</tr>
<tr>
<td>Days to Silking</td>
<td>59</td>
<td>53</td>
<td>57.28</td>
</tr>
<tr>
<td>Days to Anthesis</td>
<td>59</td>
<td>53</td>
<td>56.32</td>
</tr>
<tr>
<td>Anthesis Silking Interval(ASI)</td>
<td>3.5</td>
<td>0</td>
<td>0.95</td>
</tr>
<tr>
<td>Plant height (cm)</td>
<td>197</td>
<td>104</td>
<td>157.3</td>
</tr>
<tr>
<td>Ear height (cm)</td>
<td>102.5</td>
<td>44</td>
<td>70.52</td>
</tr>
<tr>
<td>Kernels rows ear⁻¹</td>
<td>19</td>
<td>11</td>
<td>13.96</td>
</tr>
<tr>
<td>Moisture content (%)</td>
<td>30.55</td>
<td>13.25</td>
<td>26.73</td>
</tr>
<tr>
<td>100 kernels weight (g)</td>
<td>42.9</td>
<td>23.05</td>
<td>33.78</td>
</tr>
<tr>
<td>Grain Yield (kg ha⁻¹)</td>
<td>11018.5</td>
<td>987.5</td>
<td>2723.91</td>
</tr>
</tbody>
</table>

100-Kernels Weight

Highly significant differences (P≤0.01) were observed among the half sib families for 100-kernels weight. Mean value ranged from 23.05g (HSF-132) to 42.90g (HSF-23) while the grand mean was recorded as 33.78g (Table 2). Rahman et al. (2007) also reported similar results for this character while comparing original and selected maize population. Co-efficient of variation was recorded as 12.68% with moderate heritability estimates of 52.66% (Table 1). Sijpriharti et al. (2003) reported high heritability estimate of 80% for 100-kernel weight. The difference in heritability estimates may be because of the different genotypes used in the experiments. Kernel weight along with plant and ear height is a major yield contributing trait and is an important parameter for selection (Dash, 1992).
Table 3. Phenotypic correlation coefficients of days to pollen shedding and silking, plant and ear height, kernel rows per year and ear length with grain yield

<table>
<thead>
<tr>
<th>TRAITS</th>
<th>Days to Silking</th>
<th>Days to Anthesis</th>
<th>Anthesis Silking Interval</th>
<th>Plant height</th>
<th>Ear height</th>
<th>Grain Moisture</th>
<th>100 kernels weight</th>
<th>Grain yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to Tasseling</td>
<td>0.491***</td>
<td>0.644***</td>
<td>-0.023**</td>
<td>-0.034NS</td>
<td>-0.022NS</td>
<td>-0.058NS</td>
<td>0.004**</td>
<td>-0.153**</td>
</tr>
<tr>
<td>Days to Silking</td>
<td></td>
<td></td>
<td></td>
<td>-0.062**</td>
<td>-0.075NS</td>
<td>-0.161**</td>
<td>-0.011**</td>
<td>-0.101**</td>
</tr>
<tr>
<td>Days to Anthesis</td>
<td></td>
<td></td>
<td></td>
<td>-0.635**</td>
<td>-0.077**</td>
<td>-0.107**</td>
<td>-0.077**</td>
<td>-0.097**</td>
</tr>
<tr>
<td>Anthesis Silking Interval</td>
<td></td>
<td></td>
<td></td>
<td>0.079NS</td>
<td>0.026NS</td>
<td>0.042NS</td>
<td>-0.044NS</td>
<td>-0.004NS</td>
</tr>
<tr>
<td>Plant height</td>
<td></td>
<td></td>
<td></td>
<td>0.591**</td>
<td>0.081NS</td>
<td>-0.087NS</td>
<td>0.143**</td>
<td></td>
</tr>
<tr>
<td>Ear height</td>
<td></td>
<td></td>
<td></td>
<td>0.022NS</td>
<td>0.111**</td>
<td>0.263**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain Moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.018NS</td>
<td>0.119**</td>
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<tr>
<td>100 kernels weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.246**</td>
</tr>
</tbody>
</table>

ns = Non significant
* = Significant at 5% level of significance, respectively
** = Significant at 1% level of significance, respectively

Grain Yield

Grain yield is the most important and prime objective in maize breeding programs. Analysis of variance regarding grain yield revealed highly significant differences among the half sib families. These results are in agreement to those observed by Noor et al. (2010) who reported significant differences for grain yield. Grain yield among 196 half-sib families ranged from 887.50 kg/ha to 4330.5 kg/ha (Table 2). Heritability estimate of 12.03% was recorded for grain yield. Akber et al. (2008) reported high heritability estimate (82%) for grain yield. Low heritability is common for grain yield because of the involvement of large number of genes and high influence of environmental factors (Welsa, 1981). Positive correlation was recorded among grain yield and other traits except days to mid-silking and Anthesis Silking Interval (Table 3). These results are in agreement to those reported by Eleweanya (2005) who also reported negative correlation between grain yield and days to mid-silking.

CONCLUSION AND RECOMMENDATIONS

Present study revealed the presence of significant variation among the half sib families for grain yield and related traits, therefor the ongoing recurrent half sib family selection need to be continued. Among the 196 families HDF-22, 51, 81 and 98 took minimum for days for maturity traits and can be used in the further breeding programs for early maturity. For yield and related traits HSF-152, 23, 117, 119, 75 and 179 showed the maximum values and are considered to be utilized as parents in the coming recombination phase.

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