Middle-East Journal of Medicinal Plants Research 1(4): 80-85, 2012
ISSN 2309-8929

DOI: 10.5829/idosi.mejmpr.2011.1.4.1118

# Evaluation of Half -Sib Families Derived from Maize Variety Sarhad White for Grain Yield and Agronomic Traits

[1]Nazir Ahmad, [1]Hidayat-ur-Rahman, [1]Faizan Mahmood,
[1]Shahab Ahmad, [2]Rifat Ali and [3]Abbas Ali

[1]Department of Plant Breeding and Genetics, The University of Agriculture Peshawar, Pakistan
[2]Deparment of Plant Pathology, The University of Agriculture Peshawar, Pakistan
[3]Deparment of Weed Science, The University of Agriculture Peshawar, Pakistan

**Abstract:** This study was undertaken at the Research Farm of KP Agricultural University, Peshawar during 2012 to evaluate half-sib maize families for grain yield and agronomic traits. Forty nine half-sib families derived from maize variety Sarhad White were used in the study. The experiment was laid out in 7×7 partial balance lattice design with two replications. Results indicated that the half-sib families were significantly different from one another for all the traits studied. Among the 49 half-sib families minimum days to 50% tasseling (50.0) were recorded for HS-32 while HS-48 showed maximum days to 50% tasseling (60.0). Minimum days to 50% silking (51.0) were observed for HS-08 while HS-48 showed maximum days to mid tasseling. Minimum plant height of 110.50 cm was recorded for HS-41 while HS-08 showed maximum plant height (160.60 cm), minimum ear height (40.70 cm) was recorded for HS-41 and maximum ear height (79.60 cm) for HS-48. Minimum grain moisture (14.0%) was recorded for HS-03 while maximum (30.60%) for HS-12. Minimum ear length (9.20 cm) was recorded for HS-41 while maximum (14.80 cm) was for HS-04. Minimum grain yield (3133.0 kg ha$^{-1}$) was recorded for HS-43 while HS-06 showed maximum (7423.0 kg ha$^{-1}$) grain yield. Maximum heritability estimate (0.84) was observed 100-kernal weight, while minimum (0.42) was observed for yield. Maximum correlation of yield was recorded with plant height and 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:** *Zea mays* L. · Sarhad White · Heritability · Correlation

## INTRODUCTION

Medicinal plants are an significant source of manufacturing valuable bioactive compounds which is great importance for the health of individuals and communities. The medicinal importance of the plants is due to the secondary metabolites that produce a definite physiological action on human body [1-4]. Maize (*Zea mays* L.) is one of the most important cereal crops of the world grown in the irrigated and rainfed areas. It is a cross pollinated, annual and short day crop that can be grown in tropical and sub-tropical regions with high temperature and enough sunshine. It can be grown on all types of soils ranging from sandy to clay; however, medium textured soil of pH 6.5 to 7.5 is more suitable for maize. Maize plant is protandrous in which pollen shedding normally begins 1-3 days before the silks have emerged from the husks of the same plant and usually continues for a period of several days after the silks are ready to be pollinated. Hot dry weather tends to hasten the pollen shedding [5]. Maize is a multipurpose crop used for food, feed, fodder and several industrial products. About two third of the total world production of maize is used for livestock feed or for commercial starch and oil production. It has a great nutritional value as it contains about 66.7% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugar and 7% ash [6]. Maize ranks 3$^{rd}$ most grown crop in the world with an area of 161 million hectares with total production tons 840 million tons, having an average yield of 519461.1 kg hac$^{-1}$ [7]. In Pakistan maize is the 4$^{th}$ largest grown crop after wheat, cotton and rice. In Pakistan during the year 2011-12, maize

**Corresponding Author:** Nazir Ahmad, Department of Plant Breeding and Genetics, The University of Agriculture Peshawar, Pakistan.

was planted on 1083 thousand hectares with total production of 4271 thousand tons, having an average yield of 3893 kg $ha^{-1}$ (Federal Bureau of Statistics 2011-12). [8]. The major limiting factors for the low yield per unit area include unavailability of suitable and inexpensive maize hybrid seed, associated with price of hybrid seed, thus forcing the farmers to plant open pollinated varieties. The ultimate goal of various breeding methods in maize is the production of improved genotypes. Various methods for breeding maize such as mass selection, modified ear to row selection, modified mass selection, $S_1$ line, reciprocal, full-sib and half-sib recurrent selection have been utilized by the maize breeders to bring improvement in maize population and production, an ideal evaluation procedure would permit the identification of elite genotypes in the breeding scheme at minimum cost and labor.

The objective of this study were to evaluate half-sib families which were derived from the maize variety Sarhad White and to identify superior half-sib families for yield and yield related traits that can be used in future breeding programms.

## MATERIALS AND METHODS

The experiment was conducted at the Research Farm of KP, University of Agricultural Peshawar, Pakistan during summer crop season 2012. Experimental material comprised 49 half-sib families, derived from maize variety Sarhad White which was earlier developed at CCRI (Cereal Crops Research Institute) Pirsabak, Nowshera. Half sib families have one parent in common and were produced in isolation during the spring crop season (February-June) of the same year (2012) at CCRI, Pirsabak by planting the male and female rows in a ratio 1:2. The experiment was laid out in Partial lattice square design with two replications. Plant to plant and row to row distance was 25 cm and 75 cm, respectively. Data on morphological and yield parameters were recorded during the course of the experiment, appropriate for each parameter.

Silking data were recorded on plant basis as the number of days from sowing until 50% of plants in the plot showed silks while days to anthesis were worked out by visual observation when 50% of the plants in the plot started shedding pollen. The days were counted from date of sowing. Plant height was measured as distance in cm from ground level to the upper most node of the plant on five randomly selected plants $plot^{-1}$, whereas ear height measurements were taken as the average distance in cm from ground level to the node bearing uppermost ear on five randomly selected plants $plot^{-1}$. Ear length was measured from the base to the tip of the ear with scale in cm on a similar sample of five ears, whereas kernel rows per ear were counted on five randomly selected ears after harvest. The moisture contents of the grains were taken using grain moisture tester, after shelling the middle rows from five randomly selected ears at the time of harvest. Hundred grains were counted randomly from the grain lot of each plot and weighed with the help of electronic balance. Grain yield per hectare was calculated from the data of fresh weight per $plot^{-1}$ and adjusted to15% grain moisture level.

**Statistical Analysis:** The data were subjected to ANOVA appropriate for Lattice Square Design, using computer program 'MSTAT-C'. Means of all parameters were also calculated for relative comparison among the half sib families. Variance components and heritability estimates were computed following Fehr [9].

## RESULTS AND DISCUSSION

**Flowering Traits:** Highly significant differences ($P \leq 0.01$) were observed among the half sib families for days to mid tasseling and mid anthesis. Low coefficient of variation (CV) was observed for days to mid anthesis (3.00) and mid tasseling (3.55) (Table 1). These results are in agreement with those of Hidayatullah also observed highly significant differences for mid-tasseling, mid anthesis and mid silking while evaluating the performance of local and exotic inbred lines of maize under agro-ecological conditions of Peshawar [10]. Coors reported that four cycles of combined half sib and S1 family selection resulted 3.5% increase in grain yield and grain moisture reduction by 1.5% per cycle in maize synthetic [11].

HS-32 took minimum days (50.0) to mid tasseling, while maximum days (62.0) were recorded for HS-48 (Table 2). Similarly HS-15 took minimum days (53.0) to mid anthesis, while maximum days (66.0) were recorded for HS-48 (Table 2).

**Plant and Ear Height:** Plant and ear height play an important role in plant lodging. Therefore, maize breeders give special attention to these two traits in maize breeding. Low plant height and central or near to central placement of the top ear on the plant is desired, because such plants are less vulnerable to lodging and hence could contribute to enhanced grain yield. Analysis of variance regarding plant and ear height revealed significant ($P \leq 0.05$) differences among the half sib families

Table 1: Mean square values, coefficient of variation and heritability estimates for flowering, plant, ear and yield traits of half-sib families.

| Plant Trait | Replications | Families | Blocks | Error | CV (%) | $h^2$ (BS) |
|---|---|---|---|---|---|---|
| Days to tasseling | 28.66 | 8.66** | 8.11 | 3.63 | 3.55 | 0.55 |
| Days to anthesis | 4.08 | 7.52** | 5.84 | 2.93 | 3.00 | 0.57 |
| Plant height (cm) | 2797.52 | 232.78* | 223.75 | 132.54 | 8.57 | 0.45 |
| Ear height (cm) | 904.94 | 108.88* | 148.65 | 52.82 | 13.51 | 0.51 |
| Grain moisture (%) | 1.19 | 22.33** | 3.14 | 2.77 | 7.11 | 0.83 |
| Ear length (cm) | 8.90 | 3.42** | 1.12 | 1.02 | 8.34 | 0.65 |
| Kernel rows $cob^{-1}$ | 1.08 | 1.92** | 0.58 | 0.88 | 7.08 | 0.52 |
| 100-kernel wt. (g) | 5.87 | 20.4** | 3.02 | 2.39 | 4.91 | 0.84 |
| Grain yield (kg $ha^{-1}$) | 76835720 | 1299890* | 642055 | 797653 | 18.00 | 0 .42 |

* = Significant at 5% level of significance

** = Significant at 1% level of significance

Table 2: Mean values and ranges for days to tasseling and silking, plant height, ear height, grain moisture content, ear length, number of grain rows $ear^{-1}$, 100-grain weight and grain yield of half sib families

| Plant Parameter | Minimum | Maximum | Mean |
|---|---|---|---|
| Days to tasseling (number) | 50 | 62 | 53.62 |
| Days to anthesis (number) | 51 | 65 | 57.41 |
| Plant height (cm) | 110.5 | 160.6 | 134.3 |
| Eer height (cm) | 40.7 | 79.6 | 53.7 |
| Grain moisture (%) | 14 | 30.6 | 23.4 |
| Ear length (cm) | 9.2 | 14.8 | 12.1 |
| Kernel rows $cob^{-1}$ (number) | 10.3 | 15 | 12.6 |
| 100-kernel weight (g) | 24 | 37 | 31.4 |
| Grain yield (Kg $ha^{-1}$) | 3133 | 7423 | 4838.5 |

Table 3: Correlation coefficients of days to tasseling and silking, plant and ear height, kernel rows $ear^{-1}$ and ear length with grain yield

| | DT | DA | PH | EH | MC | CL | KR/EAR | 100GWT | YIELD |
|---|---|---|---|---|---|---|---|---|---|
| DT | -- | 0.89** | -0.08NS | 0.01NS | -0.006NS | -0.09 NS | 0.06 NS | 0.09NS | -0.23* |
| DA | | -- | -0.03 NS | 0.087NS | -0.12 NS | -0.09NS | 0.03 NS | 0.16 NS | -0.09NS |
| PH | | | -- | 0.77** | 0.15 NS | 0.28** | 0.12NS | -0.01 NS | 0.46** |
| EH | | | | -- | 0.12 NS | 0.16 NS | 0.12 NS | 0.08 NS | 0.36** |
| MC | | | | | -- | 0.07 NS | -0.05 NS | -0.009NS | -0.13NS |
| CL | | | | | | -- | -0.17NS | -0.07NS | 0.20* |
| KR/EAR | | | | | | | -- | -0.01NS | 0.29** |
| 100GWT | | | | | | | | -- | 0.17NS |
| YIELD | | | | | | | | | -- |

NS = Non significant

* = Significant at 5% level of significance

** = Significant at 1% level of significance

for these two traits. Stromberg and Campton [12] also reported significant differences regarding plant and ear height after 10 cycles of full-sib recurrent selection in Nebraska Krung open pollinated maize. Coefficient of variation (CV) for plant and ear height was 8.57 and 13.51%, respectively (Table 1) and were therefore in the acceptable range as commonly observed in field experiments.

Short stature plants were observed for HS-4 (110.50cm) whereas taller plants were common in HS-08 (160.60 cm). For ear height, minimum value (48 cm) was observed for HS-98 while maximum value (97.5 cm) was recorded for HS-78 (Table 2). Moderate heritability estimate of 0.45 was observed for plant height, whereas for ear height heritability estimate was 0.51 (Table 1). Ojo *et al*. (2006) and Mahmood *et al*. (2004) reported heritability estimates of 0.45 and 0.99, respectively for plant height in maize. Plant and ear height were having a positive and highly significant correlation with grain yield (Table 3).

**Grain Moisture at Harvest (%):** Grain moisture at harvest in maize helps in determining early and late maturity among the genotypes. Analysis of variance regarding grain moisture at harvest revealed highly significant ($P \leq 0.01$) differences among the half sib families. HS-03 exhibited minimum and HS-12 showed maximum grain moisture content at harvest which was 14.0% and 30.60%, respectively. Co-efficient of variation was recorded as 7.11% with a grand mean of 23.4. High heritability estimate of 0.83 was observed for grain moisture at harvest. A negative and non-significant correlation of grain moisture content was observed with grain yield (Table 3).

**Ear Length (cm):** Maize ear-length is a primary yield component affecting the net grain yield of maize plant. Statistical analysis of the data regarding ear length revealed highly significant genetic variation ($P \leq 0.01$) among the half sib families used in this study. Carlone and Russel obtained significant differences for ear length among testcrosses of maize synthetic 'BSSS' lines. Coefficient of variation (CV) for ear length was 8.34% (Table 1) [13]. Maximum ear length (14.8 cm) was recorded for HS-04, while minimum (9.2 cm) was obtained for HS-41 (Table 2). Heritability estimate of ear length was 0.65 which can be classified as high in nature (Table 1). Mahmood reported the heritability estimate of 0.85 for ear length in maize genotypes [14]. There was a positive and significant correlation (0.20) between ear length and grain yield (Table 3).

**Kernel Rows Ear$^{-1}$:** Kernel rows ear$^{-1}$ is an important yield parameter which can significantly contribute to the grain yield and ultimately total grain production. Data regarding kernel rows ear$^{-1}$ showed highly significant variation ($P \leq 0.01$) among the half sib families. Our results are supported by the findings of Saleem] who observed highly significant differences among the genotypes for kernel rows ear$^{-1}$ [15]. Coefficient of variation (CV) for kernel rows ear$^{-1}$ was 7.08% (Table 1). Minimum kernel rows ear$^{-1}$ (10) was observed for HS-32, while maximum (16) was obtained for HS-49 (Table 2). Moderate heritability estimate of 0.52 was manifested for this parameter (Table I). Contrary to our results, Mahmood reported high heritability estimate of 0.87 for kernel rows ear$^{-1}$ [15]. The difference in results might be attributable to the variations in the environment being encountered in the two studies. Kernel rows ear$^{-1}$ is the most important yield component and greater number of kernel rows ear$^{-1}$ is associated with higher grain yield [16]. As a component of grain yield, kernel rows ear$^{-1}$ has a positive relationship with grain yield and is usually given special consideration in maize improvement programs.

**100-Kernel Weight (g):** Data pertaining to 100-kernel weight, revealed highly significant differences ($P \leq 0.01$) among the half sib families (Table 1). Rahman) also reported significant differences for this trait while comparing original and selected maize populations for grain yield traits. Coefficient of variation was 4.91%. Minimum 100- seed weight (24g) was recorded for HS-15 whereas maximum (37g) was observed for HS-31 (Table 2) [16]. A high heritability estimate of 0.84 was observed for 100-kernel weight (Table 1). Sjiprihati [13] reported a high heritability estimate of 0.80 for 100-kernel weight. Dash reported that 100-seed weight along with plant height and ear length is the major yield contributing factor and is important parameter for selection [18]. Non-significant correlation of lower magnitude (0.17) was observed for grain yield and 100-kernels weight (Table 3), which is in contrary with the results of Eleweanya [19].

**Grain Yield (kg ha$^{-1}$):** Grain yield is the most important and complex character with which a breeder works. It is a function of numerous biochemical and physiological processes that operate throughout the life cycle of crop plants [20]. Several methods of selection have been used by maize breeders to improve yield per unit area and develop high yielding genotypes. Recurrent selection based on $S_1$ progenies is a good method of achieving improvement within populations Moll and Smith [21] and has been proposed as a particularly promising mean of improving grain yields.

Statistical analysis of the data regarding grain yield revealed significant genetic variation ($P \leq 0.05$) among the half sib families. Our results are consistent with that of Tanner and Smith [22] who conducted eight cycles of half-sib family and $S_1$ progeny recurrent selection in cv. Krug and obtained significant variances among testcrosses for grain yield. HS-06 showed the maximum grain yield (7423 kg ha$^{-1}$) while HS-33 was the lowest in performance, with grain yield of 3133 kg ha$^{-1}$ (Table 2). Moderate heritability estimate of 0.42 was observed for grain yield (Table 1). Akbar and Ojo reported [23, 24] a high heritability ($h^2$) estimate of 0.82 and 0.99 for this trait, respectively. Low heritability value for grain yield is usually common because of involvement of large number of genes and high influence of environmental interaction [25]. Positive correlation was observed among grain yield and other traits observed in this study, except days to tasseling, days to anthesis and moisture content at harvest (Table 3). Eleweanya obtained negative correlation between grain yield and days to mid silking while Akbar reported negative phenotypic correlation between grain yield and ear height in maize [24].

## CONCLUSION AND RECOMMENDATIONS

HS-06, HS-07, HS-23, HS-38 and HS-39 gave the highest grain yield. Therefore, these lines could be further evaluated in test cross combinations to test their relative potential as parents in future maize breeding schemes. HS-22, HS-45, HS-46, HS-47 in addition to having satisfactory grain yield took less days to pollen shedding. Such half-sib families could be used to develop hybrids for areas having short growing season. Heritability estimates of all the traits were medium to high which shows considerable environmental influence in the expression of these plant characters.

## REFERENCES


1. Rauf, A., A. Khan, S. Rasool, Z. Ali Shah and M. Saleem, 2012. "*In vitro* Antifungal Activity of Three Selected Pakistani Medicinal Plants." (2012). Middle-East Journal of Medicinal Plants Research 1(2): 41-43.
2. Uddin G., A. Rauf, B. Siddiqui and S.Q. Shah, 2011. Preliminary Comparative phytochemical Screening of Diospyros Lotus Stewart, Middle-East J. Scientific Research, 10(1): 78-81.
3. Uddin, G., A. Rauf, T.U. Rehman and M. Qaisar M, 2011. Phytochemical screening of *Pistacia chinensis* var. *integerrima,* Middle-East Journal of Scientific Research, 7: 707-711.
4. Uddin, G. and A. Rauf, 2012. Phytochemical screening, antimicrobial and antioxidant activities of aerial parts of *Quercus robur* L, Middle-East J. Med. Pl Res., 1(1): 01-04.
5. Poehlman, J.M., 1977. Breeding Field Crops. 2nd. The AVI Publish. Co. Inc. Westport, Connecticut.
6. Chaudhary, A.H., 1983. Effect of population and control of weeds with herbicides in maize. Field Crop Abstract, 35(5): 403.
7. FAO, 2011-12. Food and Agriculture Organization.
8. FBS, 2011-12. Federal Bureau of Statistics.
9. Fehr, W.R., 1987. Principles of cultivar development. Macmillan Publish. Co. New York, (1): 351-353.
10. Hidayatullah, I.H. Khalil G. Hassan, Iltafullah and H. Rahman, 2006. Performance of local and exotic inbred lines of maize under agro-ecological conditions of Peshawar. Sarhad Journal of Agriculture, 22(3): 409-414.
11. Coors, J.G., 1988. Response to four cycles of combined half-sib and $S_1$ family selection in maize. Crop Science, (28): 891-896.
12. Stromberg, D.C. and W.G. Campton, 1989. Ten cycles of full-sib recurrent selection in maize. Crop Sciences, (29): 1170-1172.
13. Carlone, M.R. and W.A. Russell, 1989. Evaluation of $S_2$ maize lines reproduced for several generations by random mating within lines II. Comparisons for test cross performance of the original and advanced $S_2$ and $S_8$ lines. Crop Sci., (29): 899-904.
14. Mahmood, Z., S.R. Manlike, R. Akhtar and T. Rafique, 2004. Heritability and genetic advance estimates from maize genotypes in Shishi Lusht, a valley of Karakuram. Intentional Journal of Agriculture, Biology, 6(5): 790-795.
15. Saleem, A., U. Saleem and G.M. Subhani, 2007. Correlation and path coefficient analysis in maize. Journal of Agriculture Resurch, 45(3): 177-183.
16. Rahman, H., I.H. Khalil, N. Islam, Durrishahwar and A. Rafi, 2007. Comparison of original and selected maize populations for grain yield traits. Sarhad J. Agric., 21(2): 231-235.
17. Sjiprihati, S., G.B. Saleh and E.S. Ali, 2003. Heritability, performance and correlation studies on single cross hybrids of tropical maize. Asian Journal of Plants Sciences, 2(1): 51-57.
18. Dash, B., S.V. Singh and J.P. Shah, 1992. Character association and path analysis in $S_1$ lines of maize. Maydica, 43: 217-226.
19. Eleweanya, N.P., M.I. Uguru and E.E. Ene-Obong, 2005. Correlation and path coefficient analysis of grain yield related chatacters in maize (*Zea mays* L.) under umudike condtitions of south eastern Nigeria. Agro. Science, 4(1): 24-28.
20. Fakorede, M.A.B. and J.J. Mock, 1980. Growth analysis of maize variety hybrids obtained from two recurrent programmes for grain yield. New Phytopathol, 85(3): 393-408.
21. Moll, R.H. and O.S. Smith, 1981. Genetic variances and selection responses in an advanced generation of a hybrid of widely divergent populations of maize. Crop Sciences, 21: 387-391.
22. Tanner, A.H. and O.S. Smith, 1987. Comparison of half-sib and $S_1$ recurrent selection in the krug yellow dent maize populations. Crop Sciences, 27: 509-513.

23. Akbar, M., M.S. Shakoor, A. Hussain and M. Sarwar, 2008. Evaluation of maize 3- way crosses through genetic variability, broad sense heritability, characters association and path analysis. Journal of Agriculture Resurch, 46(1): 39-45.
24. Ojo, D.K., O.A. Omikunle, O.A. Oduwaye, M.O. Ajala and S.A. Ogunbayo, 2006. Heritability, character correlation and path coefficient analysis among six inbred-lines of maize. World Journal of Agriculture Sciences, 2(3): 352-358.
25. Welsh, J.R., 1981. Fundamentals of Plant Breeding. John Wiley & Sons, New York, pp: 134-135.